SOIL SURVEY OF

Washington and Ramsey Counties Minnesota

United States Department of Agriculture
Soil Conservation Service
in cooperation with
the Minnesota Agricultural Experiment Station

HOW TO USE

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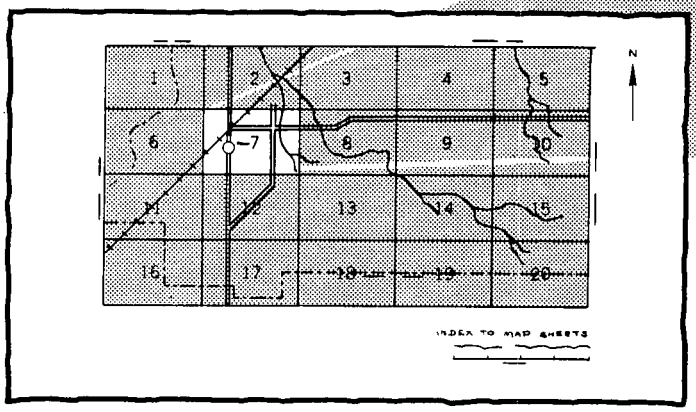

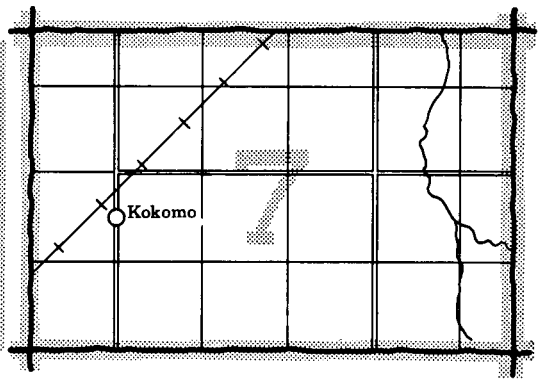

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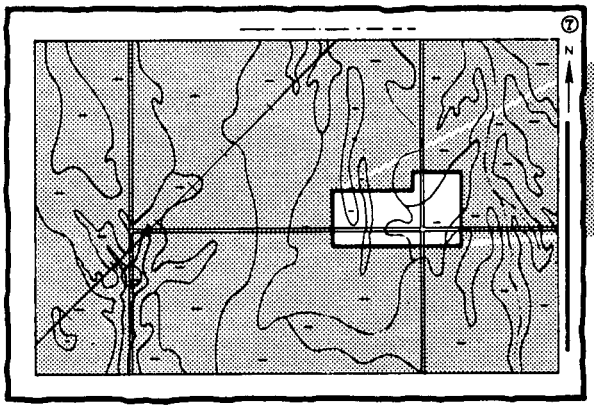

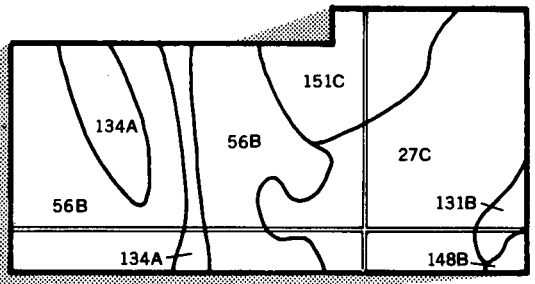

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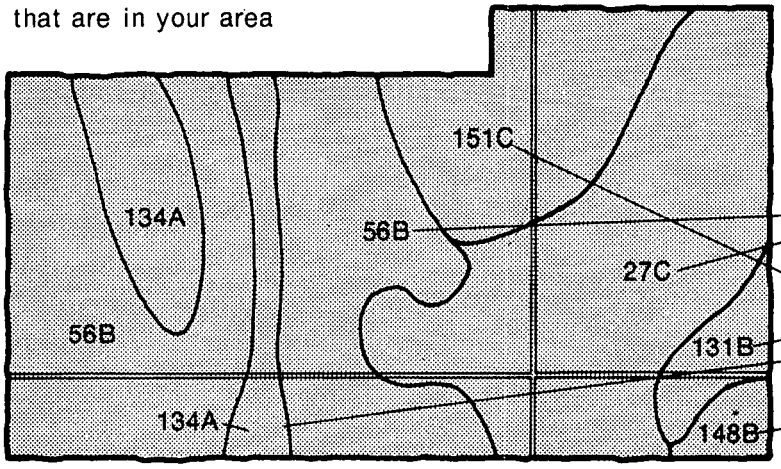

Symbols

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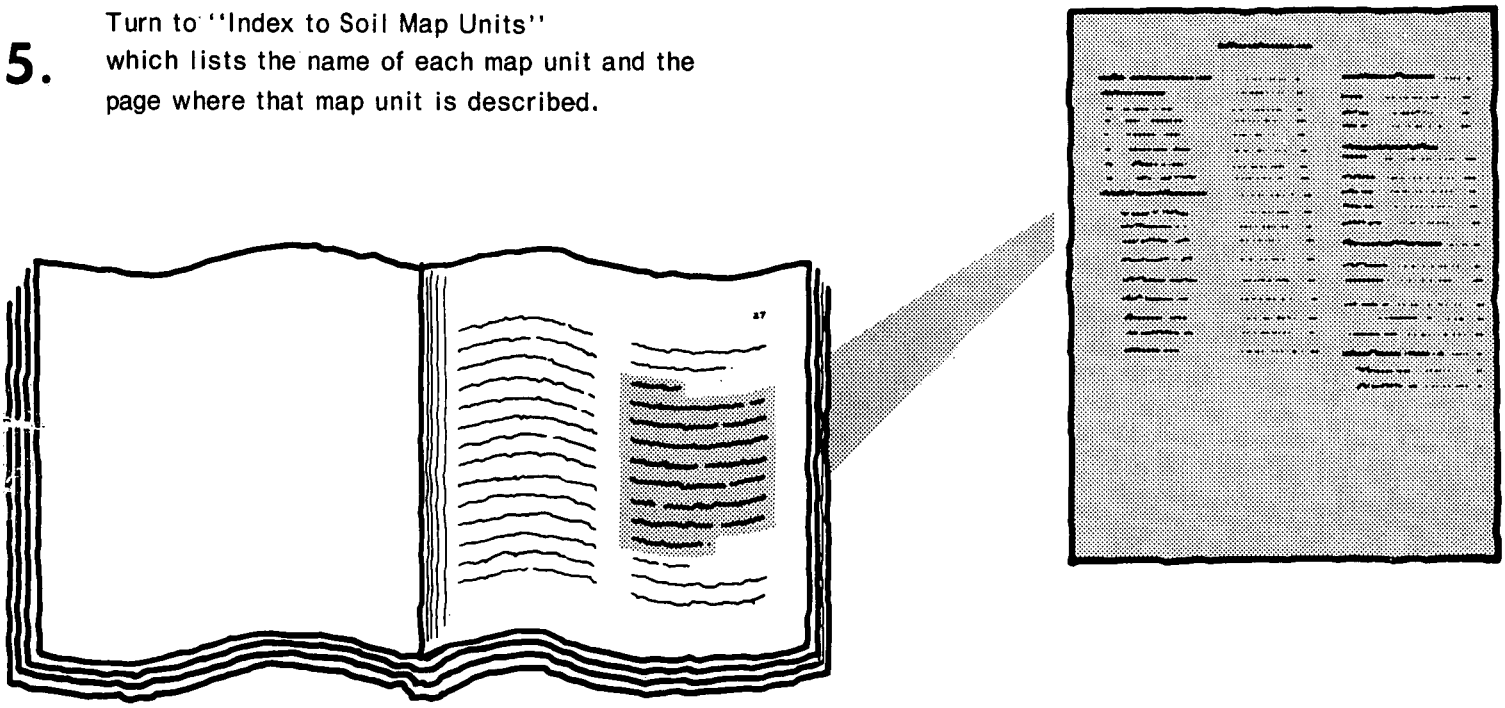
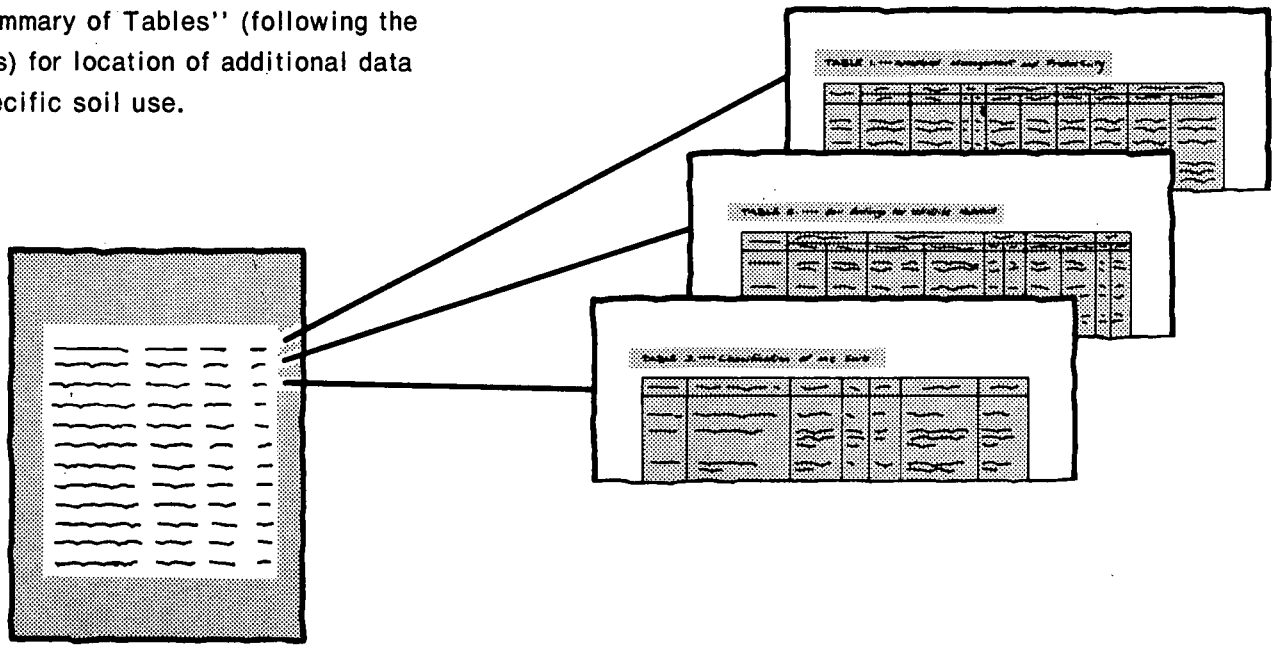
131B
134A
148B
151C

THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1973-77. Soil names and descriptions were approved in 1977. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1977. This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. It is part of the technical assistance furnished to the Washington and Ramsey Soil and Water Conservation Districts.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

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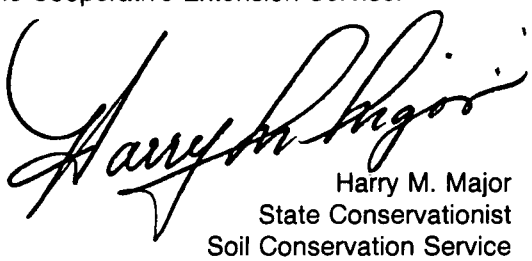
This soil survey contains information that can be used in land-planning programs in Washington and Ramsey Counties. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.



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SOIL SURVEY OF WASHINGTON AND RAMSEY COUNTIES, MINNESOTA

By Kenneth R. Vinar, Soil Conservation Service

Field survey by Kenneth R. Vinar, Keith A. Christensen, John O. Nordin, and David V. Wroblewski, Soil Conservation Service; Roger S. Johnson, Washington County Soil and Water Conservation District; and Roger L. Berggren, Minnesota Agricultural Experiment Station

United States Department of Agriculture, Soil Conservation Service in cooperation with the Minnesota Agricultural Experiment Station

Washington and Ramsey Counties are located in the eastern part of Minnesota (fig. 1). They have a total land area of 352,000 acres—249,600 acres in Washington County and 102,400 in Ramsey County—and a water area of about 25,600 acres. Washington County is bordered on the east by the St. Croix River and on the west by Ramsey County. Ramsey County is bordered on the west by Hennepin and Anoka Counties. The city of Stillwater is the county seat of Washington County, and St. Paul is the county seat of Ramsey County.

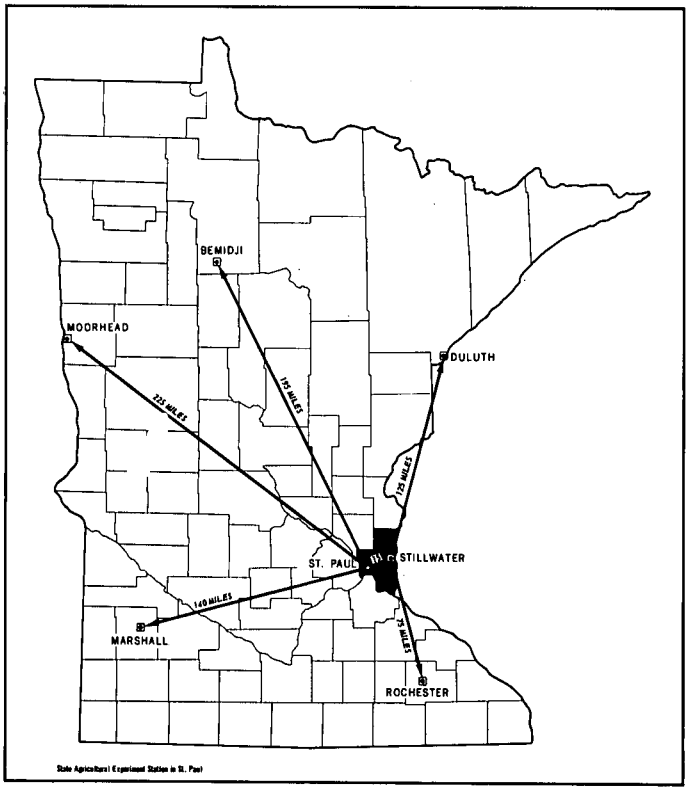

Figure 1.—Location of Washington and Ramsey Counties in Minnesota.

General nature of the counties

Farming is the leading enterprise in Washington County, and corn, soybeans, oats, and hay are the main cash-grain crops. Dairying and stock raising are an added source of income in some areas. Commerce and industry are important occupations in Ramsey County. The large tracts of woodland in northern Washington County and north-central Ramsey County provide some cash income from the sale of firewood and other wood products. The wooded tracts and the many lakes are becoming increasingly important as recreational areas. They are also highly desirable as homesites for the expanding population around the metropolitan area.

Washington and Ramsey Counties have dark colored and light colored, level to very steep soils that formed in loess or glacial material. The original vegetation was medium and tall prairie grasses and mixed hardwood forest. Most of the soils in Ramsey County have been altered by urbanization and other activities of man.

Climate

In Washington and Ramsey Counties, winters are very cold and the summers are short and fairly warm. The short freeze-free period during the summer limits cropping mainly to forage, small grains, and adapted vegetables. Precipitation is fairly well distributed throughout the year, reaching a slight peak in summer. Snow covers the ground much of the time from late fall through early spring.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at St. Paul, for the period 1956 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 17 degrees F, and the average daily minimum is 8 degrees. The lowest temperature on record, -29 degrees, occurred at St. Paul on January 29, 1966. In summer the average temperature is 70 degrees, and the average daily maximum is 80 degrees. The highest temperature, 97 degrees, was recorded on July 8, 1974.

Growing degree days, shown in table 1, are equivalent to "heat units." Beginning in spring, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 20 inches, or 71 percent, usually falls during the period April through September, which includes the growing season for most crops. Two years in 10, the April-September rainfall is less than 17 inches. The heaviest 1-day rainfall during the period of record was 4.97 inches at St. Paul on June 1, 1965. Thunderstorms number about 36 each year, 22 of which occur in summer.

Average seasonal snowfall is 46 inches. The greatest snow depth at any one time during the period of record was 36 inches. On the average, 70 days have at least 1 inch of snow on the ground, but the number of days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night in all seasons, and the average at dawn is about 80 percent. The percentage of possible sunshine is 67 percent in summer and 50 percent in winter. The prevailing direction of the wind is from the northwest. Average windspeed is highest, 12 miles per hour, in April.

Soils occasionally freeze to a depth of several feet when very cold weather occurs before the ground is appreciably covered with snow. Usually the soil is frozen in only the top few inches to 1 foot, except where the snow cover has been removed.

Physiography, relief, and drainage

Washington and Ramsey Counties are dominated by the Eastern St. Croix Moraine. This glacial end and terminal moraine is characterized by steep hills interspersed with deep depressions. These depressions are occupied by small lakes or are filled with peat.

Along the northern part of Ramsey County and the northwestern part of Washington County, islands of glacial till protrude through the sandy deposits of the Anoka Sand Plain. This is a gently undulating outwash plain made up principally of fine sand. Depressions are commonly filled by peat deposits, marshes, or lakes.

The Mississippi River Valley Outwash covers the southwestern parts of both counties and the east-central part of Washington County. It is characterized by nearly level terraces and flood plains along the major rivers and their tributaries.

The southeastern part of Washington County is dominated by the Kenyon-Taopi Plain. This is a sloping, silt-mantled, eroded till plain characterized by long swells and swales. It has a well established dendritic, or branching, drainage pattern.

The drainage of Washington and Ramsey Counties is unusual. In spite of the proximity of the deep-cut valleys of the St. Croix and Mississippi Rivers, only two short perennial streams, Rice Creek and Battle Creek, flow from the uplands into these drainageways. Elsewhere the drainage is downward into underlying sand and gravel or bedrock, or it travels short distances through swales and shallow, indefinite valleys and empties into lakes and depressions.

The highest elevation is about 1,104 feet above sea level, within the area dominated by the Eastern St. Croix Moraine, in section 17 of Woodbury township in Washington County. The lowest elevation, about 675 feet above sea level, is at the extreme southern tip of Washington County where the St. Croix River flows into the Mississippi.

History

Father Louis Hennepin is believed to have passed through the survey area in 1680. The territory was at that time claimed by the French, later by the British, and did not become United States property until 1783 with the signing of the Treaty of Paris. In 1849, when Congress authorized the organization of the Minnesota Territory, Washington and Ramsey Counties were two of the original nine counties. The city of Stillwater is considered the "Birthplace of Minnesota."

Settlement was slow at first, mainly by soldiers and trappers. The pine forests along the St. Croix River attracted the first groups of settlers. After the government purchased the triangle of land between the St. Croix and Mississippi Rivers from the Indians in 1837, lumbermen quickly moved into the area. The first lumber was sawed at Marine-on-St. Croix in 1839. Shortly after the lumberman, the pioneer farmers, artisans, townsite speculators, storekeepers, doctors, and teachers began to arrive.

Lumbering was the main attraction to early settlers, and it remained important until the early 1900's. The first farmers settled in the Newport, Afton, and Cottage Grove areas. Wheat was the chief crop in this early period, but its importance has diminished and corn, soybeans, and oats are the major money producing crops today. The early agricultural output in Ramsey County consisted chiefly of specialty crops (truck crops, dairy products, and orchard products). The accessibility of good markets favored the development of these products. Where agriculture is still carried on in Ramsey County today, truck crops and orchard products are mostly grown.

Ramsey County is mainly urban, because its location at the junction of the Mississippi and Minnesota Rivers is ideal for a trade center. Washington County, on the other

hand, has been agricultural until recent years. The rapid influx of people has lately transformed much of Washington County for urban uses. It has become a major transportation center, receiving railroad, highway, airline, and river traffic from other parts of the United States and the world. The area also has publishing and communications, merchandising, recreational, and educational industries.

How this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil maps for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, woodland managers, engineers, planners, developers and builders, home buyers, and others.

General soil maps for broad land use planning

The general soil maps at the back of this publication show broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil maps can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of their small scale, the maps are not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Washington County

Soils formed dominantly in outwash

These soils are underlain by fine sand to gravelly coarse sand and are on outwash plains and stream terraces. They range from excessively drained, somewhat excessively drained, and well drained to somewhat poorly drained and very poorly drained. Slopes are level to steep. These soils formed under deciduous hardwood forest or prairie.

Three of the map units of Washington County are in this group.

1. Zimmerman-Isanti-Lino

Level to steep, excessively drained, somewhat poorly drained, and very poorly drained, coarse textured soils; on outwash plains

This map unit mostly occupies a broad, gently rolling sand plain, and the lower lying areas have a natural high water table. Slope is dominantly 0 to 12 percent, but ranges to 25 percent next to drainageways and depressions.

This map unit makes up about 4 percent of the total land area in Washington County. It is about 30 percent Zimmerman and similar soils, 15 percent Isanti and similar soils, 10 percent Lino soils, and 45 percent soils of minor extent (fig. 2).

The Zimmerman soils are excessively drained and range from level to steep. They are on convex parts of knolls, ridgetops, and side slopes near drainageways and depressions. They have a surface layer of dark grayish brown loamy fine sand and a subsurface layer of grayish brown loamy fine sand. The subsoil and underlying material are multi-colored fine sand. The seasonal high water table is usually below a depth of 6 feet.

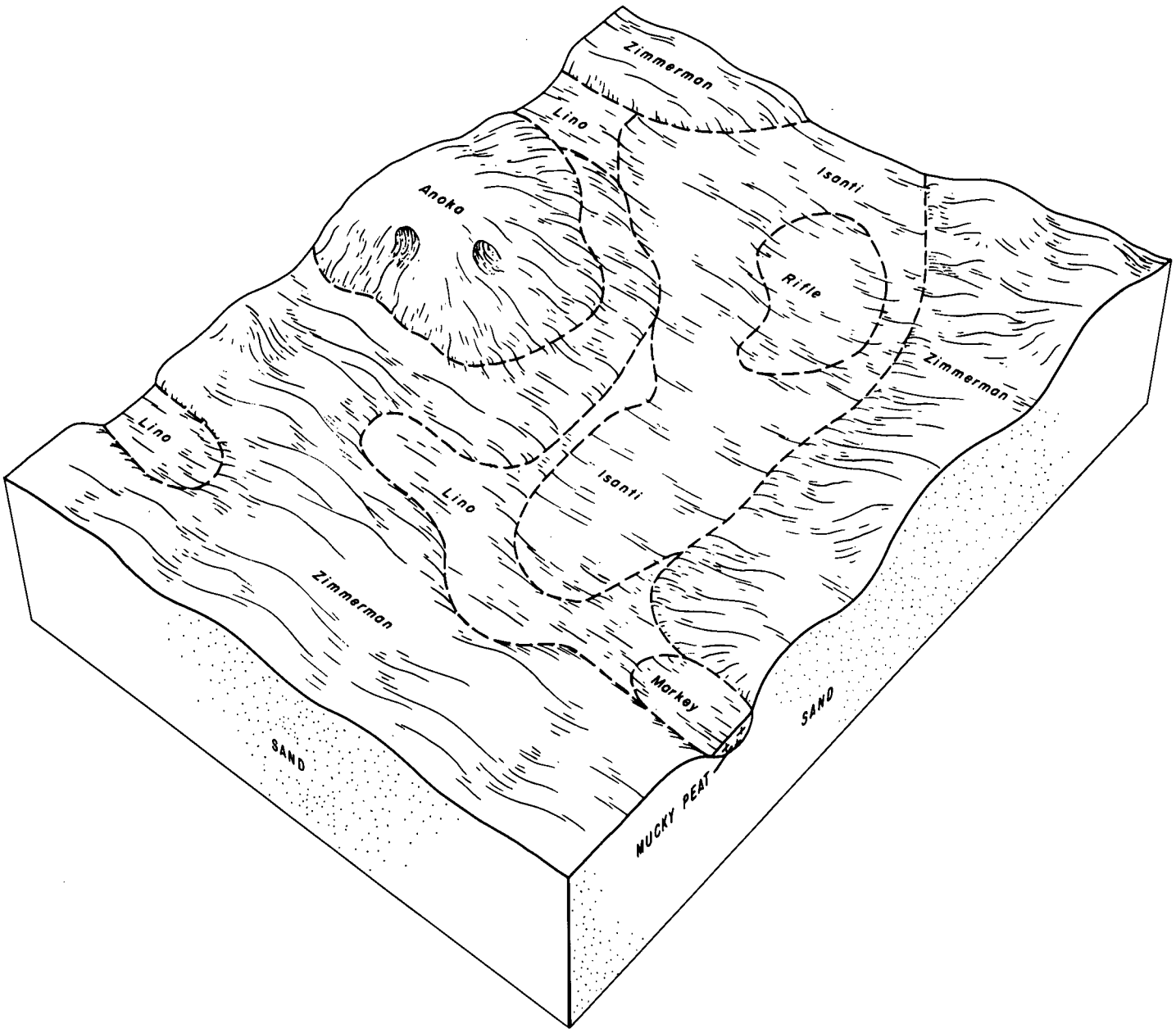

Figure 2.—Pattern of soils and parent material in the Zimmerman-Isanti-Lino map unit.

The Isanti soils are very poorly drained, and they occupy depressions and low lying flats. They have a surface layer of black loamy fine sand; a subsoil of dark gray and grayish brown loamy fine sand and fine sand; and gray loamy fine sand underlying material. The seasonal high water table ranges from the surface to a depth of 2 feet.

The Lino soils are somewhat poorly drained and occupy small flats and depressions. The surface layer is dark grayish brown loamy fine sand. The subsoil is pale brown and light brownish gray, mottled loamy fine sand. The underlying material is light brownish gray, mottled fine sand. A seasonal high water table is at a depth of 2 to 4 feet.

Of minor extent in this map unit are Anoka, Lino Variant, Markey, and Rifle soils and areas of Urban land. Anoka soils are well drained and nearly level to sloping. They are sandy and have loamy bands in the subsoil.

Markey and Rifle soils are very poorly drained and are in small to large bogs. Lino Variant soils are moderately well drained and are in slightly convex positions on the landscape. Areas of Urban land within this map unit are used for residential development and are covered by concrete, asphalt, and buildings.

This map unit is used mostly for general farming. Corn, soybeans, and small grains are the common crops. Many formerly idle fields are planted to coniferous trees, which are harvested as Christmas trees. Some areas are used for wildlife. Small areas are used for rural residences.

If these soils are farmed, the main concerns of management are low available water capacity, low natural fertility, and the severe hazard of wind erosion. In the lower areas a high water table is also a concern. The soils of this unit are fairly well suited to pasture and woodland. The Zimmerman and Lino soils are suited to building site development. There is a hazard of pollution of underground water supplies and nearby lakes and streams when this map unit is used for septic tank absorption fields or other sanitary facilities.

2. Antigo-Chetek-Mahtomedi

Nearly level to steep, well drained to excessively drained, medium textured to coarse textured soils; mostly on outwash plains

This map unit is on nearly level to steep outwash plains. Slope is mostly 1 to 18 percent but is steeper along depressions and lakes.

This map unit makes up about 40 percent of the total land area in Washington County. It is about 27 percent Antigo soils, 15 percent Chetek and similar soils, 14 percent Mahtomedi soils, and 44 percent soils of minor extent.

The Antigo soils are well drained and are mostly nearly level to gently rolling. They are on slightly concave to convex ridgetops. Their surface layer is dark grayish brown silt loam, and the subsurface layer is dark grayish brown silt loam. The subsoil is dark brown silt loam in the upper part and dark brown loamy sand in the lower part. The underlying material is dark brown gravelly sand. A seasonal high water table is below a depth of 6 feet.

The Chetek soils are somewhat excessively drained and are nearly level to steep. They are on convex knolls and crests and side slopes of hills. The surface layer is dark grayish brown sandy loam, and the subsurface layer is brown loam. The upper part of the subsoil is dark reddish brown gravelly sandy loam, and the lower part is brown gravelly coarse sand. The underlying material is brown and light brown gravelly sand and gravelly coarse sand. A seasonal high water table is below a depth of 6 feet.

The Mahtomedi soils are excessively drained and undulating to steep. They are on convex ridgetops and side slopes. Their surface layer is very dark gray loamy sand, and the subsurface layer is brown sand. The upper part of the subsoil is dark brown gravelly coarse sand, and the lower part is reddish brown gravelly coarse sand. The underlying material is reddish brown and light reddish brown gravelly sand. A seasonal high water table is below a depth of 6 feet.

The minor soils in this map unit are Brill, Kingsley, Barronett, and Zimmerman soils and areas of Urban land. The Brill soils are moderately well drained and are in drainageways and slight depressions. The Kingsley soils are well drained and are gently sloping to steep. They are on hillsides and knolls, and they formed entirely in glacial till. The Barronett, sandy substratum, soils are poorly drained and occupy deep depressions and low drainageways. The Zimmerman soils are excessively drained. They formed in fine sands and are on knolls and side slopes on lake plains. Urban land consists of areas of residential development and areas covered by concrete, asphalt, and buildings.

Most of this map unit is used for cultivated crops or pasture. Corn, small grains, and alfalfa are the main crops. Many areas are in woodland. Some areas are used for rural residences or hobby farms.

The main concerns of management if these soils are farmed are their low available water capacity and their susceptibility to erosion. They range from well suited to only fairly suited to pasture and woodland. They are well suited as building sites. There is a hazard of ground water pollution if sanitary facilities are placed on these soils.

3. Sparta-Dickman-Hubbard

Level to moderately steep, excessively drained and somewhat excessively drained, moderately coarse textured and coarse textured soils; mostly on outwash terraces

This map unit is on level to moderately steep valley trains and terraces. Slope is mostly 0 to 12 percent, but it is steeper on terrace escarpments and along drainageways or depressions.

This map unit makes up about 7 percent of the total land area in Washington County. It is about 40 percent Sparta soils, 10 percent Dickman and similar soils, 10 percent Hubbard soils, and 10 percent soils of minor extent.

The Sparta soils are excessively drained and are level to moderately steep. They occupy broad flats and low, convex side slopes or knolls. They have a surface layer of black loamy sand and a subsurface layer of very dark grayish brown loamy sand. The subsoil is dark brown loamy sand. The underlying material is brown sand. A seasonal high water table is at a depth of more than 6 feet.

The Dickman soils are somewhat excessively drained and are level to moderately sloping. They occupy flats and low, convex slopes and knolls. They have a surface layer of very dark brown sandy loam. The subsoil is dark brown sandy loam in the upper part, dark brown loamy

sand in the middle part, and dark yellowish brown sand in the lower part. The underlying material is yellowish brown sand. A seasonal high water table is at a depth of more than 6 feet.

The Hubbard soils are excessively drained and very gently sloping to moderately steep. They occupy broad flats and low concave or convex side slopes or knolls. Typically, the surface layer is very dark gray and dark brown loamy sand. The subsoil is dark brown and brown sand. The underlying material is brown sand. A seasonal high water table is below a depth of 6 feet.

The minor soils in this map unit are the Burkhardt, Algansee, and Copaston soils and Urban land. The Burkhardt soils are somewhat excessively drained and on flats. The Algansee soils are somewhat poorly drained and occasionally flooded. They are on flood plains. The Copaston soils are well drained and nearly level. They are on bedrock terraces. Urban land consists of areas of residential development and is covered by concrete, asphalt, and buildings.

Most of this map unit is used for cash-grain crops. Small grains, alfalfa, and corn are the major crops. Many areas are developed for nonfarm uses. Small areas are a source of sand and gravel, and some limestone is quarried.

The main concerns of management when these soils are farmed are their low available water capacity and susceptibility to soil blowing. They have only fair suitability for pasture and woodland. They are well suited as building sites. There is a hazard of pollution of underground water supplies and nearby lakes and streams if septic tank absorption fields or other sanitary facilities are placed on these soils.

Soils formed dominantly in glacial till

These are mostly broad upland soils that formed in loamy glacial till. They are well drained, moderately well drained, and poorly drained and are level to steep. They formed under deciduous hardwood forest.

Four of the map units of Washington County are in this group.

4. Hayden-Kingsley

Undulating to steep, well drained, moderately coarse textured soils; on uplands

This map unit is on undulating to steep glacial till plains. Slope is mostly 2 to 25 percent but ranges to 30 percent. The steeper slopes are along depressions and drainageways.

This map unit makes up about 1 percent of the total land area in Washington County. It is about 40 percent Hayden and similar soils, 35 percent Kingsley soils, and 25 percent soils of minor extent (fig. 3).

The Hayden soils are well drained and undulating to steep. They occupy ridge crests and side slopes. They have a dark grayish brown fine sandy loam surface layer and a grayish brown fine sandy loam subsurface layer. The subsoil is dark yellowish brown and yellowish brown sandy loam, loam, and clay loam. The underlying material is yellowish brown and light olive brown mottled loam. The seasonal high water table is usually below a depth of 6 feet.

The Kingsley soils are well drained and undulating to steep, and they are on knolls and side slopes. They have a dark brown sandy loam surface layer, a reddish brown sandy loam subsoil, and reddish brown sandy loam underlying material. The seasonal high water table is usually below a depth of 6 feet.

The minor soils in this map unit are the Auburndale, Nessel, Ronneby, Dundas, Rifle, and Bluffton soils and areas of Urban land. The Nessel soils are moderately well drained and nearly level. Slopes are plane to slightly convex. The somewhat poorly drained Ronneby soils and poorly drained Auburndale and Dundas soils are in small depressions and drainageways. The very poorly drained organic Rifle soils occupy depressions, and the very poorly drained Bluffton soils are in low-lying depressions or on rims around the organic soils. Urban land consists of soil covered by concrete, asphalt, and buildings.

This map unit is predominantly used for crops and pasture. Corn, small grains, and alfalfa are the main crops. Some small areas are used for rural residences. The major limitation to nonfarm uses is the degree of slope and slow percolation rates.

If these soils are farmed, the main concerns of management are erosion control and maintenance of fertility. The soils are well suited to pasture, woodland, and as building sites. If they are used for septic tank absorption fields, the filter field should be large enough to function properly in the moderately slowly permeable underlying material of the Kingsley soils.

5. Nessel-Dundas-Webster

Level to gently undulating, moderately well drained and poorly drained, moderately coarse textured and medium textured soils; on uplands

This map unit is on level to gently undulating glacial till plains where there are many swales and drainageways. Slope ranges from 0 to 4 percent.

This map unit makes up about 4 percent of the total land area in Washington County. It is about 20 percent Nessel soils, 15 percent Dundas soils, 15 percent Webster and similar soils, and about 50 percent soils of minor extent (fig. 4).

The Nessel soils are moderately well drained. They are gently undulating and are on slight rises, low knolls, and broad tops of low hills. Slopes are plane to slightly convex. These soils have a very dark gray fine sandy loam surface layer and a dark grayish brown fine sandy loam subsurface layer. The subsoil is brown and grayish brown mottled fine sandy loam and loam. The underlying material is light olive brown, mottled fine sandy loam. A seasonal high water table is at a depth of 3 to 5 feet.

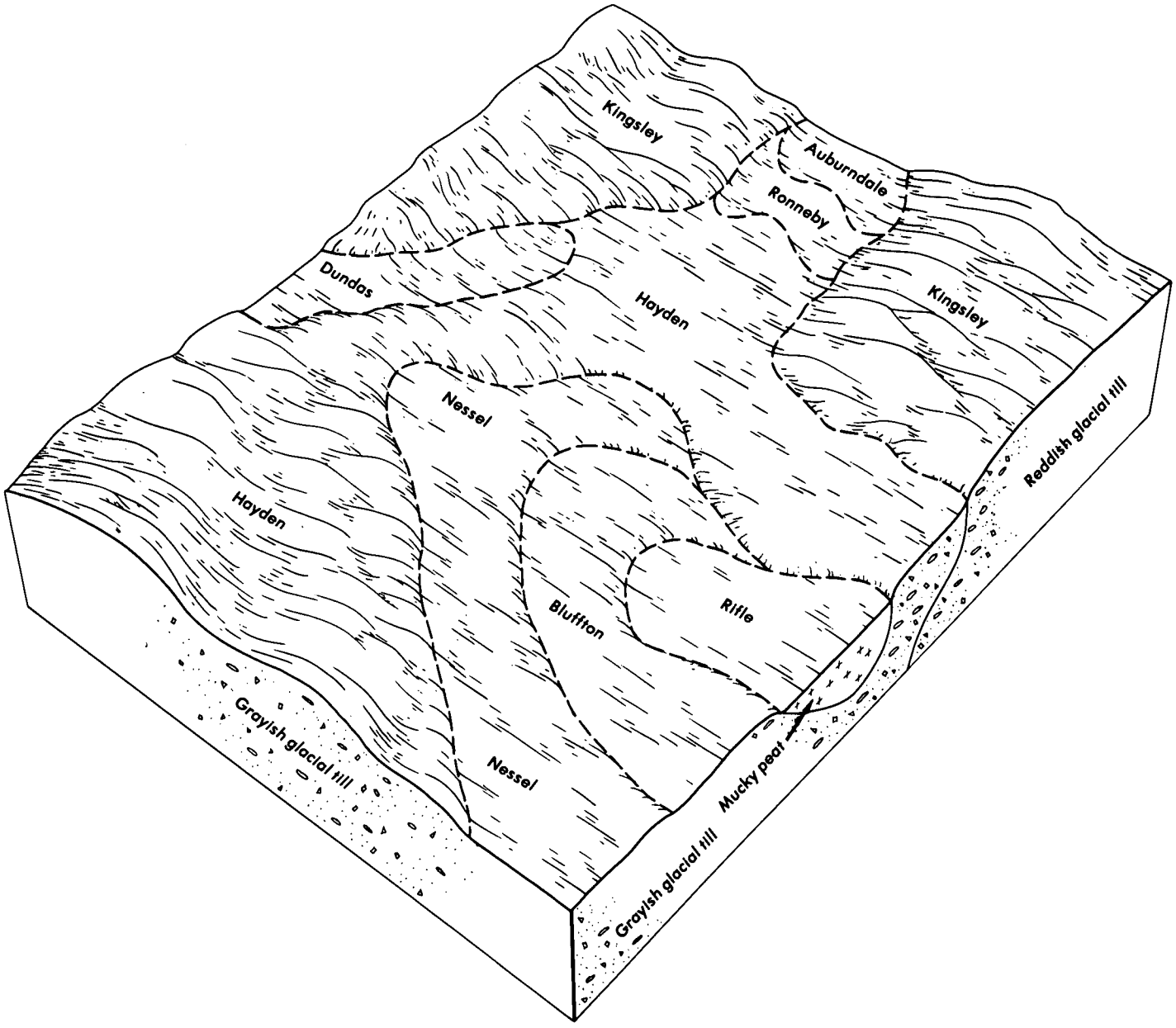

Figure 3.—Pattern of soils and parent material in the Hayden-Kingsley map unit.

The Dundas soils are poorly drained and are in drainageways and low-lying areas. Slopes are plane and concave. These soils have a very dark gray fine sandy loam surface layer. The subsurface layer and subsoil are mottled, grayish brown sandy clay loam. The underlying material is grayish brown mottled loam. A seasonal high water table is at a depth of 1 to 3 feet.

The Webster soils are poorly drained and occupy low-lying areas and small drainageways. Slopes are plane to slightly concave. They have a black loam surface layer, a black and very dark gray clay loam subsurface layer, an olive gray loam subsoil, and olive gray and gray sandy clay loam underlying material. A seasonal high water table is at a depth of 1 to 3 feet.

The minor soils in this map unit are Rifle, Cathro, Kratka, Bluffton, Blomford, Braham, and Hayden soils and areas of Urban land. The Rifle and Cathro soils are very poorly drained organic soils in depressions. The

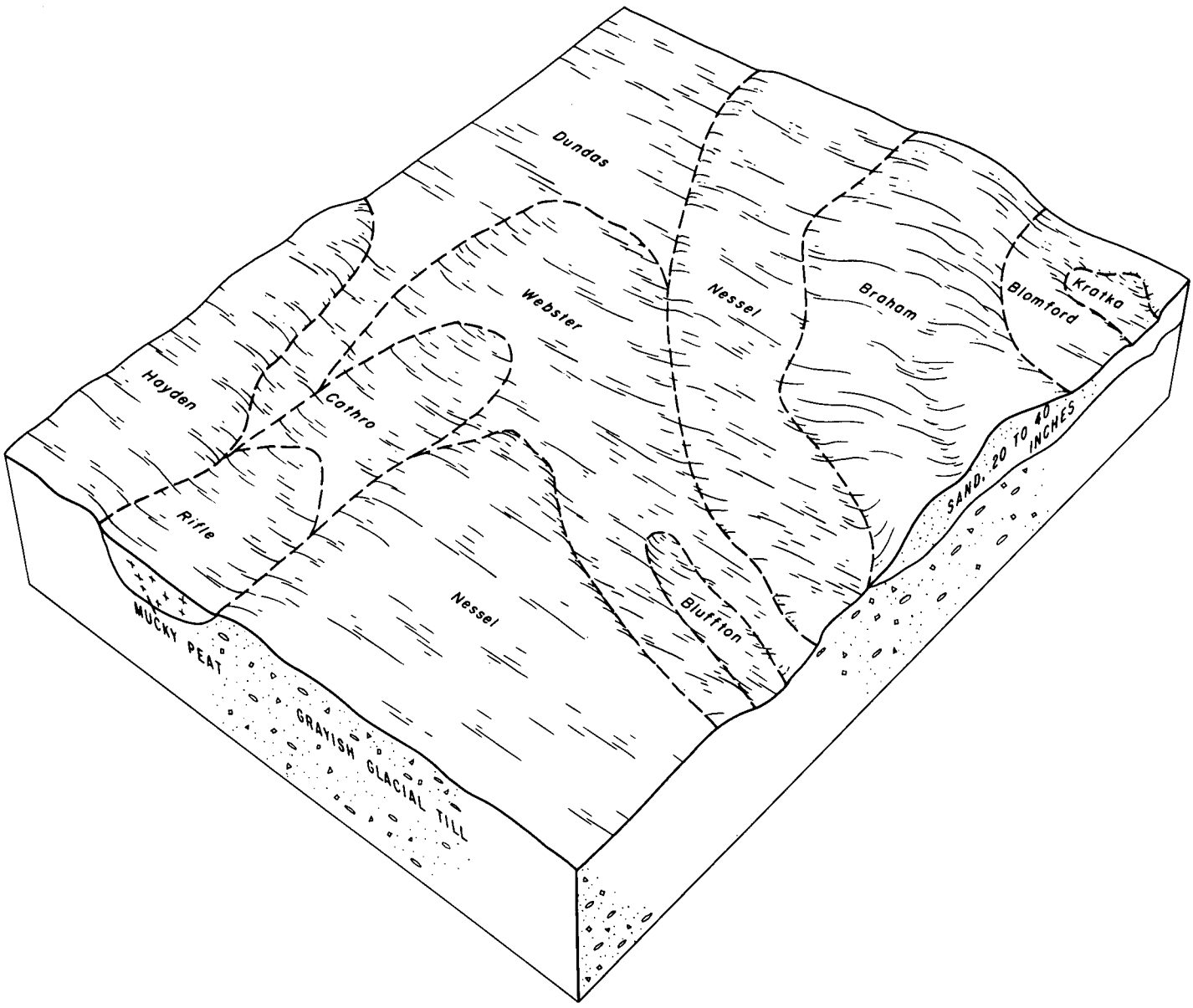

Figure 4.—Pattern of soils and parent material in the Nessel-Dundas-Webster map unit.

Kratka and Bluffton soils are also very poorly drained and are in small depressions or drainageways or on rims around organic soil. The Blomford soils are poorly drained and nearly level and are in sand-capped areas. The Braham soils are well drained and gently sloping to sloping. They are on sand-capped crests and sides of hills. The Hayden soils are well drained and undulating to gently rolling. Urban land consists of areas of residential development and is covered by concrete, asphalt, and buildings.

This map unit is mostly farmed. Corn, soybeans, and alfalfa are the main crops. Some small areas are under residential development.

Maintenance of tilth and fertility is the main management need if these soils are farmed. In addition, Dundas and Webster soils require drainage to remove excess water. These soils are well suited to pasture. They have fair to poor suitability for woodland because of the seasonal high water table. They also have fair to poor suitability for building site development because they have a seasonal high water table, low strength for supporting foundations, and moderate shrink-swell potential. There

is a hazard of ground water pollution when they are used for sanitary facilities.

6. Hayden-Nessel-Dundas

Level to gently rolling, well drained, moderately well drained, and poorly drained, moderately coarse textured soils; on uplands

This map unit consists of level to gently rolling soils that formed in calcareous, loamy glacial till. It is on low, irregular hills and knolls and on side slopes adjacent to drainageways and depressions. Slope ranges from 0 to 12 percent.

This map unit makes up about 3 percent of the total land area of Washington County. It is about 30 percent Hayden and similar soils, 15 percent Nessel soils, 15 percent Dundas soils, and 40 percent soils of minor extent.

The Hayden soils are well drained and are undulating to gently rolling. They are on irregular hills and knolls. They have a dark grayish brown fine sandy loam surface layer and a grayish brown fine sandy loam subsurface layer. The subsoil is dark yellowish brown and yellowish brown sandy loam, loam, and clay loam. The underlying material is yellowish brown and light olive brown loam. The seasonal high water table is at a depth of more than 6 feet.

The Nessel soils are moderately well drained. They are gently undulating and are on slight rises, low knolls, and broad tops of low hills. Slopes are plane to slightly convex. These soils have a dark gray fine sandy loam surface layer and a dark grayish brown fine sandy loam subsurface layer. The subsoil is brown and grayish brown mottled fine sandy loam and loam. The underlying material is light olive brown, mottled fine sandy loam. A seasonal high water table is at a depth of 3 to 5 feet.

The Dundas soils are poorly drained and occupy small flats adjacent to drainageways in the upland. They have a very dark gray fine sandy loam surface layer. The subsurface layer and subsoil are mottled, grayish brown sandy clay loam. The underlying material is grayish brown, mottled loam. A seasonal high water table is at a depth of 1 to 3 feet.

The minor soils in this map unit are Webster, Bluffton, Rifle, and Cathro soils and areas of Urban land. The Webster soils are poorly drained and level. The Bluffton, Rifle, and Cathro soils are very poorly drained and are in depressions and drainageways. Urban land consists of areas of residential development and is covered by concrete, asphalt, and buildings.

This map unit is mainly used for cash-grain farming. Corn, small grains, and alfalfa are the main crops. Some small areas are used for rural residences. Additional areas are used for recreation and wildlife.

A high water table in low areas and the hazard of erosion on the steeper slopes are the main limitations to farming these soils. They have good to fair suitability for woodland. When they are used as building sites the main limitations are low strength, frost action, and wetness.

7. Santiago-Kingsley

Undulating to steep, well drained, medium textured and moderately coarse textured soils; on uplands

This map unit is on undulating to steep glacial till uplands. Slope is 2 to 24 percent.

This map unit makes up about 19 percent of the total land area in Washington County. It is about 40 percent Santiago soils, 25 percent Kingsley soils, and 35 percent soils of minor extent.

The well drained Santiago soils are undulating to hilly. They are on low knolls and on crests and sides of hills on ground moraines. These soils have a very dark grayish brown silt loam surface layer and a dark brown silt loam subsurface layer. The subsoil is dark yellowish brown and dark brown silt loam in the upper part and reddish brown and dark reddish brown sandy loam in the lower part. The underlying material is dark reddish brown sandy loam. A seasonal high water table is below a depth of 6 feet.

The well drained Kingsley soils are undulating to steep. They occupy irregular shaped knolls and narrow side slopes on end and ground moraines. They have a dark brown sandy loam surface layer, a reddish brown sandy loam subsoil, and reddish brown sandy loam underlying material. The seasonal high water table is below a depth of 6 feet.

The minor soils in this map unit are Duluth, Freeon, Chetek, Freer, Ronneby, and Auburndale soils and Urban land. The well drained Duluth soils formed in loamy glacial till. The Freeon soils are moderately well drained and nearly level to gently undulating. The well drained Chetek soils formed in a loamy mantle overlying sand and gravel. The Freer and Ronneby soils are somewhat poorly drained and are in depressions and drainageways. The Auburndale soils are very poorly drained and are in depressions. Urban land consists of areas of residential development and is covered by concrete, asphalt, and buildings.

Most of this map unit is cropped to corn, soybeans, and alfalfa. The steeper slopes are in pasture or woodland. Some areas are used for rural residences or hobby farms. Other areas are used for recreation and wildlife.

If these soils are farmed, the main concerns of management are steepness of slope and susceptibility to erosion. They are well suited to pasture and woodland. They have good to fair suitability for urban uses. Steepness of slope and moderately slow permeability are the main limitations to using the soils as building sites or for sanitary facilities.

Soils formed dominantly in a sandy mantle and underlying glacial till and in glacial till

These are mostly upland soils that formed in about 20 to 40 inches of sandy eolian or lacustrine sediments over glacial till. They are well drained and poorly drained and are nearly level to steep. They formed under deciduous hardwood forest.

Two of the map units of Washington County are in this group.

8. Demontreville-Kingsley

Undulating to steep, well drained, coarse textured and moderately coarse textured soils; on uplands

This map unit is on convex, irregular shaped knolls and upper side slopes. Slope is mostly 0 to 18 percent, but is steeper, up to 30 percent, around the depressions and lakes scattered throughout the unit.

This map unit makes up about 3 percent of the total land area in Washington County. It is about 50 percent Demontreville soils, 30 percent Kingsley soils, and 20 percent soils of minor extent.

The well drained Demontreville soils are undulating to steep and are on convex crests and upper parts of side slopes. They have a dark grayish brown loamy fine sand surface layer and a brown loamy fine sand and loamy sand subsurface layer. The subsoil is brown loamy sand in the upper part and dark reddish brown sandy loam in the lower part. The underlying material is dark reddish brown sandy loam. A seasonal high water table is at a depth of more than 6 feet.

The well drained Kingsley soils are undulating to steep and occupy crests and narrow side slopes of knolls, hills, and irregular areas. Slopes are plane to convex. They have a dark brown sandy loam surface layer and a reddish brown sandy loam subsoil. The underlying material is reddish brown sandy loam. A seasonal high water table is at a depth of more than 6 feet.

The minor soils in this map unit are Prebish, Rifle, Seelyeville, Cathro, Ronneby, and Santiago soils and Urban land. The Prebish, Rifle, Seelyeville, and Cathro soils are poorly and very poorly drained and are in depressions and lower parts of drainageways. The Ronneby soils are somewhat poorly drained and are in upper parts of drainageways. The Santiago soils are well drained and are on crests of hills and upper side slopes. Urban land consists of areas of residential development and is covered by concrete, asphalt, and buildings.

Most of this map unit is used for pasture or woodland and some for cash-grain farming. Corn, small grains, and alfalfa are the major crops. Other areas are used for homesteads or small hobby farms.

If these soils are farmed, the main concerns of management are low available water, susceptibility to erosion, and soil blowing. These soils have only fair suitability for pasture and woodland. They have good suitability for urban uses and fair suitability for recreation.

9. Braham-Blomford-Urban land

Nearly level to hilly, well drained and poorly drained, coarse textured soils and Urban land; on uplands

This map unit consists of soils that formed in a 20- to 40-inch sandy mantle and the underlying loamy glacial till. Slope ranges from 1 to 15 percent, with the steeper slopes around depressions and drainageways.

This map unit makes up about 1 percent of the total land area in Washington County. It is about 30 percent Braham soils, 25 percent Blomford soils, 15 percent Urban land, and about 30 percent soils of minor extent.

The Braham soils are well drained and are gently undulating to hilly. They occupy slightly concave to convex side slopes and crests of knolls and hills. They have a dark grayish brown loamy fine sand surface layer and a yellowish brown loamy fine sand subsurface layer. The subsoil is dark yellowish brown sandy clay loam. The underlying material is olive brown fine sandy loam and loam. The seasonal high water table is usually below a depth of 6 feet.

The Blomford soils are poorly drained and nearly level. They occupy small depressions, drainageways, and flats. Slopes are slightly concave to plane. These soils have a very dark grayish brown loamy fine sand surface layer and a grayish brown loamy fine sand subsurface layer. The subsoil is grayish brown sandy clay loam. The underlying material is olive loam. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet.

Urban land consists of areas of residential development and is covered by concrete, asphalt, and buildings. Most soil materials around building foundations and most fill materials used to support structures consist of Braham or Brahamlike soils that have been cut or graded. Large areas of Urban land are mapped by themselves, and smaller areas are included in Urban land complexes.

The minor soils in this map unit are Lino, Zimmerman, Dundas, Hayden, Rifle, and Markey soils. The Lino soils are somewhat poorly drained and sandy and are in depressions. The Zimmerman soils are excessively drained and sandy and are on crests and side slopes of ridges and drainageways. The Dundas soils are poorly drained and loamy and are in depressions. The Hayden soils are well drained and are on loamy crests of hills and side slopes. The organic Rifle and Markey soils are very poorly drained and occupy depressions.

Most of this map unit is farmed. Some of it is under urban development or is in woodland or pasture. Corn, small grains, and alfalfa are the major crops.

These soils have only fair suitability for cultivated farm crops. The main concerns of management are low available water capacity, the severe hazard of wind erosion, and low natural fertility. They also have fair suitability for pasture and woodland. If these soils are used as building sites or for sanitary facilities, the main limitations are a high susceptibility to frost heave and the seasonal high water table in low areas.

Soils formed dominantly in a silty mantle and underlying sandy outwash and in silty lacustrine sediments

These are mostly soils that formed in silty eolian or lacustrine sediments over sandy outwash or in silty lacustrine sediments on glacial lake plains. They are well

drained and somewhat poorly drained and are level to moderately sloping. They formed under deciduous hardwood forest or prairie.

Only one of the map units of Washington County is in this category.

10. Antigo-Comstock

Level to moderately sloping, well drained and somewhat poorly drained, medium textured soils; on outwash plains and glacial lake plains

This map unit consists of soils that formed in 20 to 40 inches of sandy materials over sandy outwash and in stratified silty lacustrine sediments. Slope is 0 to 12 percent, with the steeper slopes along drainageways and depressions.

This map unit makes up about 3 percent of the total land area in Washington County. It is about 40 percent Antigo soils, 30 percent Comstock soils, and 30 percent soils of minor extent.

The Antigo soils are well drained and nearly level to moderately sloping. They are on broad flats, knolls, and hills. Slopes are slightly concave to slightly convex. These soils have a surface layer of very dark grayish brown silt loam and a subsurface layer of dark grayish brown silt loam. The subsoil is dark brown silt loam in the upper part and dark brown loamy sand in the lower part. The underlying material is dark brown gravelly sand. A seasonal high water table is below a depth of 6 feet.

The Comstock soils are somewhat poorly drained and are level. They are in slight depressions and drainageways. They have a very dark gray silt loam surface layer and a very dark gray silt loam subsurface layer. The subsoil is dark brown and grayish brown mottled silt loam in the upper part and brown, mottled silt loam in the lower part. The underlying material is pale brown, mottled silt loam. A seasonal high water table is at a depth of 1 to 3 feet during wet seasons.

The minor soils in this map unit are Barronett, Brill, Crystal Lake, Anoka, and Zimmerman soils and Urban land. The Barronett soils are poorly drained and are in depressions and drainageways. The moderately well drained Brill soils and well drained Crystal Lake soils are on slightly concave slopes. The well drained Anoka soils and excessively drained Zimmerman soils are level to moderately sloping. They formed in deep sandy outwash. Urban land consists of areas of residential development and is covered by concrete, asphalt, and buildings.

Most of this map unit is used for cash-grain crops. Corn, soybeans, small grains, and alfalfa are the main crops. Some of the unit is pasture or woodland. Some is used for specialty crops such as truck crops and sod. Some is used for homesteads or small hobby farms.

If these soils are farmed, the major management concern is maintenance of fertility and tilth. Some drainage is needed on the Comstock soils. Droughtiness during dry periods is a problem on Antigo soils. These soils are well suited to pasture and woodland. If they are used as building sites or for sanitary facilities, the main limitations are a high susceptibility to frost heaving and the high seasonal water table in low areas.

Soils formed dominantly in a silty mantle and the underlying loamy glacial till and in a silty mantle over bedrock

These are mostly upland soils that formed in a loess mantle over glacial till or bedrock. They are well drained and are nearly level to moderately sloping. They formed under prairie.

One map unit in Washington County is in this category.

11. Ostrander-Baytown-Ripon

Nearly level to moderately sloping, well drained, medium textured soils; on uplands

This map unit consists of soils that formed in a 24- to 40-inch loess mantle over bedrock or in the loess mantle and the underlying glacial till. Slope is 1 to 12 percent, and the steeper slopes are along drainageways and around depressions.

This map unit makes up about 5 percent of the total land area in Washington County. It is about 30 percent Ostrander soils, 10 percent Baytown and similar soils, 10 percent Ripon soils, and 50 percent soils of minor extent.

The well drained Ostrander soils are nearly level to moderately sloping. They are on broad flats and convex crests and sides of hills. They have a surface layer of very dark gray and very dark grayish brown silt loam. The subsoil is dark brown and brown silt loam in the upper part and dark yellowish brown loam in the lower part. The underlying material is yellowish brown clay loam. A seasonal high water table is at a depth of more than 6 feet.

The well drained Baytown soils are very gently sloping to moderately sloping. They are on irregularly shaped hills where bedrock is near the surface. The surface layer is very dark gray and very dark grayish brown silt loam. The upper part of the subsoil is dark brown silt loam, the middle part is dark yellowish brown loam, and the lower part is yellowish brown loamy sand. Light gray to yellow weakly indurated sandstone bedrock is at a depth of 20 to 40 inches. A seasonal high water table is at a depth of more than 6 feet.

The well drained Ripon soils are very gently sloping to gently sloping. They are on irregularly shaped hills where bedrock is near the surface. They have a surface layer of very dark gray silt loam and a subsoil of dark brown silt loam. Limestone bedrock is at a depth of 20 to 40 inches. A seasonal high water table is at a depth of more than 6 feet.

The minor soils in this map unit are the well drained Waukegan, Channahon, Gale, and Brodale soils and areas of Urban land. The Waukegan soils are on irregularly shaped hills. They formed in a silt mantle over outwash. The Channahon soils are nearly level to mod-

erately sloping and are on hills. They formed in a silt mantle over sandstone or limestone bedrock. The Gale soils are on hills. They formed in a silt mantle over sandstone. The Brodale soils are steep and are on sidewalls of drainageways. They formed in loamy residuum over limestone. Urban land consists of areas of residential development and is covered by concrete, asphalt, and buildings.

This map unit is used mostly for cash-grain farming. Corn, soybeans, small grains, and alfalfa are the major crops. The steeper slopes are used for permanent pasture or woodland. Small areas are used for homesteads or hobby farms.

If these soils are farmed, the main concerns of management are the hazard of erosion on the steeper slopes and the restricted depth of the rooting zone of the Ripon soils. These soils are generally well suited to pasture. If they are used for building sites or sanitary facilities, the main limitation is the moderate depth to bedrock of the Baytown and Ripon soils.

Soils formed dominantly in a sandy or loamy mantle over bedrock and in sandy alluvium

These are mostly soils on bedrock cored terraces and escarpments. They formed in sandy or loamy sediments over bedrock and in sandy alluvium. They are excessively drained and well drained and are nearly level to very steep. They formed under deciduous hardwood forest or prairie.

Two of the map units in Washington County are in this group.

12. Mahtomedi Variant-Copaston

Moderately sloping to very steep, excessively drained and well drained, moderately coarse textured and medium textured soils; on terraces and escarpments

This map unit consists of soils that formed in sandy outwash or loamy alluvium over sandstone or limestone bedrock. Slope ranges from 0 to more than 40 percent.

This map unit makes up about 1 percent of the total land area in Washington County. It is about 40 percent Mahtomedi Variant and similar soils, 20 percent Copaston soils, and 40 percent soils of minor extent and Rock outcrop.

The Mahtomedi Variant soils are excessively drained. They are on steep to very steep sides of escarpments. They have a very dark gray sandy loam surface layer. The subsoil is reddish brown to dark brown loamy sand in the upper part and yellowish brown sand in the lower part. Light brownish gray soft sandstone bedrock is at a depth of 40 to 80 inches. A seasonal high water table is at a depth of more than 6 feet.

The Copaston soils are well drained and level to moderately sloping. They are on rock-cored terraces. They have a very dark brown loam surface layer. The subsoil is dark brown sandy loam in the upper part and dark brown gravelly sandy loam in the lower part. Brownish yellow limestone or sandstone bedrock is at a depth of 12 to 20 inches. A seasonal high water table is at a depth of more than 6 feet.

The minor soils in this map unit are Kingsley, Chetek, Emmert, and Mahtomedi soils and areas of Rock outcrop and Urban land. The well drained Kingsley soils are on steep escarpments of glacial till. The somewhat excessively drained Chetek soils and excessively drained Emmert and Mahtomedi soils are on sandy and gravelly terraces and escarpments. Rock outcrop consists of exposures of sandstone bedrock. Urban land consists of soil material covered by concrete, asphalt, and buildings.

Most areas of this map unit are in woodland. In level areas on terraces it is used for cash-grain crops, mainly corn, soybeans, small grains, and alfalfa. Some level soils are used for cultured sod. Some small areas are used for rural residences.

These soils are poorly suited to crops because they are steep and are shallow to the underlying bedrock. They have fair to poor suitability for pasture, specialty crops, and woodland. Steepness of slope and shallowness to hard bedrock are the main limitations to using these soils as building sites or for sanitary facilities.

13. Copaston-Sparta

Nearly level to moderately steep, well drained and excessively drained, medium textured and coarse textured soils; mostly on terraces

This map unit consists of soils that formed in loamy sediments over bedrock or in glacial outwash on bedrock-cored terraces. Slope ranges from 0 to 18 percent.

This map unit makes up about 1 percent of the total land area of Washington County. It is about 40 percent Copaston soils, 20 percent Sparta soils, and 40 percent soils of minor extent.

The Copaston soils are well drained and are level to moderately sloping. They are on rock-cored terraces. Slopes are convex. These soils have a very dark brown loam surface layer and a dark brown sandy loam and gravelly sandy loam subsoil. Brownish yellow sandstone bedrock is at a depth of 12 to 20 inches. A seasonal high water table is at a depth of more than 6 feet.

The Sparta soils are excessively drained and are level to moderately steep. They are on broad flats and on convex side slopes and knolls on terraces. These soils have a black loamy sand surface layer and a very dark grayish brown loamy sand subsurface layer. The subsoil is dark brown loamy sand, and the underlying material is brown sand. A seasonal high water table is at a depth of more than 6 feet.

The minor soils in this unit are Algansee, Chaska, Dickman, Faxon, Hubbard, and Sparta soils and Urban land. The somewhat poorly drained Algansee and poorly drained Chaska soils are on occasionally flooded flood plains. The somewhat excessively drained Dickman soils formed in a loamy mantle over glacial outwash. The poorly drained and very poorly drained Faxon soils

formed in 20 to 40 inches of loamy sediments over bedrock. The excessively drained Hubbard soils formed in medium and coarse sand and gravel. The excessively drained Sparta soils that have a bedrock substratum are 40 to 60 inches deep over limestone bedrock. Urban land consists of areas of residential development and is covered by concrete, asphalt, and buildings.

This map unit is used mostly for crops. Small grains, alfalfa, and corn are the major crops. Some limestone is quarried.

If these soils are used for crops, the main limitations are low available water capacity and shallow depth to bedrock. They have fair suitability for pasture and woodland. Sparta soils are well suited as building sites, but Copaston soils are limited by shallowness to hard bedrock.

Soils formed dominantly in a silty mantle and the underlying sandy outwash and soils formed in a silty mantle over bedrock

These are mostly soils on uplands in which the configuration of the underlying bedrock determines the configuration of the landscape. They formed in silty sediments over outwash or bedrock. They are well drained and are level to moderately sloping. They formed under prairie.

One of the map units in Washington County is in this category.

14. Waukegan-Baytown-Ripon

Level to moderately sloping, well drained, medium textured soils; on uplands

This map unit consists of soils that formed in silty sediments over glacial outwash or bedrock of sandstone or limestone. Slope is typically 0 to 12 percent, and the steeper slopes are on terrace escarpments and along drainageways.

This map unit makes up about 8 percent of the total land area in Washington County. It is about 30 percent Waukegan soils, 10 percent Baytown and similar soils, 10 percent Ripon soils, and 50 percent soils of minor extent.

The well drained Waukegan soils are level to moderately sloping and are on low, irregularly shaped hills. They have a very dark brown silt loam surface layer. The subsoil is dark yellowish brown silt loam in the upper part and yellowish brown coarse sand in the lower part. The underlying material is light yellowish brown coarse sand. A seasonal high water table is at a depth of more than 6 feet.

The well drained Baytown soils are nearly level to moderately sloping. They are on irregularly shaped hills where bedrock is near the surface. The surface layer is very dark gray and very dark grayish brown silt loam. The upper part of the subsoil is dark brown silt loam, the middle part is dark yellowish brown loam, and the lower part is yellowish brown loamy sand. Light gray to yellow weakly indurated sandstone bedrock is at a depth of 20 to 40 inches. A seasonal high water table is at a depth of more than 6 feet.

The well drained Ripon soils are very gently sloping to moderately sloping. They are on irregularly shaped hills where bedrock is near the surface. They have a very dark gray and very dark grayish brown silt loam surface layer and a dark brown and brown silt loam subsoil. Limestone bedrock is at a depth of 20 to 40 inches.

The minor soils in this map unit are Richwood, Channahon, Dorerton, Antigo, and Brodale soils and areas of Urban land. The well drained Richwood soils are nearly level to gently sloping and formed in silt-capped outwash. The well drained Channahon soils are in bedrock controlled areas where a silt cap covers limestone or sandstone. The well drained Dorerton soils are on escarpments and along drainageways where a loamy mantle covers limestone bedrock and exposures of limestone bedrock are common. The well drained Antigo soils occur on outwash plains and stream terraces where silty sediments cover sand and gravel. Brodale soils are excessively drained and steep. They are on escarpments and along drainageways where a loamy mantle covers limestone bedrock. Urban land consists of areas of residential development and is covered by concrete, asphalt, and buildings.

Most of this map unit is used for cultivated crops, but a few steep areas are used for permanent pasture or wildlife. The main crops are corn, soybeans, small grains, and alfalfa, and there is some dairy and beef cattle. Some small acreages are used for homesteads. Some areas are used for recreational purposes.

If these soils are farmed, the main concerns of management are the hazard of erosion on the steeper soils and the restricted depth of the rooting zone of the Ripon soils. These soils are generally well suited to pasture. If they are used as building sites or for sanitary facilities, the main limitation is the moderate depth to bedrock of the Baytown and Ripon soils.

Ramsey County

Soils formed dominantly in outwash

These are soils underlain by fine sand to gravelly coarse sand and Urban land on uplands and stream terraces. The soils are excessively drained, somewhat excessively drained, well drained, and very poorly drained and are level to steep. They formed under deciduous hardwood forests or prairie.

Three of the map units of Ramsey County are in this group.

1. Zimmerman-Urban land-Rifle

Level to gently rolling, excessively drained and very poorly drained, coarse textured soils and organic soils and Urban land; on uplands

This map unit consists mainly of soils and Urban land on a broad outwash plain. The water table is at or near the surface in most low areas and depressions. Slope ranges from 0 to 12 percent, and the steeper areas are along drainageways and large depressions.

This map unit makes up about 27 percent of the total land area of Ramsey County. It is about 25 percent Zimmerman and similar soils, 20 percent Urban land, 10 percent Rifle soils and similar organic soils, and 45 percent soils of minor extent.

The Zimmerman soils are excessively drained and are nearly level to gently rolling. In places, they occupy steep side slopes near drainageways and depressions. The surface layer is dark grayish brown loamy fine sand, and the subsurface layer is grayish brown loamy fine sand. The subsoil and underlying material are multicolored fine sand. The water table in these soils is below a depth of 6 feet.

Urban land consists of areas of residential development and is covered by concrete, asphalt, and buildings. Most soil materials around building foundations and most fill materials used to support structures are Zimmerman or Zimmerman-like soils that have been cut or graded.

The Rifle soils are very poorly drained and level. They occupy large bogs and small depressions. They typically have a black muck surface layer. The subsurface and lower layers are strong brown, dark brown, and dark yellowish brown mucky peat. The water table is commonly at or within a foot of the surface.

The minor soils in this map unit are Udorthents, wet substratum, Lino, Isanti, and Hayden soils. The Udorthents, wet substratum, consist of filled depressional areas. The somewhat poorly drained Lino soils and very poorly drained Isanti soils occupy small flats and depressions and broad low areas. The well drained Hayden soils are on moraines and formed in calcareous gray till.

Urbanization is taking place rapidly in this map unit. Areas that have not been developed for housing include parks, playgrounds, vacant lots, isolated tracts of grassland, wooded land, and yards around and between buildings.

This map unit is well suited to urban uses which are tied in with city sewage disposal systems. The main concern when using it as building sites or for sanitary facilities is the high water table in the low areas and depressions. When it is used for sanitary facilities, there is a danger of pollution of underground water supplies. When it is used for recreational development, soil blowing is the major concern.

2. Urban land-Chetek-Mahtomedi

Urban land and nearly level to very steep, somewhat excessively drained and excessively drained, moderately coarse textured and coarse textured soils; on uplands

This map unit consists of Urban land and of soils that formed in glacial outwash on terminal moraines. Slope ranges from 0 to 40 percent.

This map unit makes up about 10 percent of the total land area of Ramsey County. It is about 30 percent Urban land, 20 percent Chetek soils, 10 percent Mahtomedi soils, and 40 percent soils of minor extent.

Urban land consists of areas of residential development and is covered by asphalt, concrete, and buildings. Soil material around building foundations and fill materials used to support structures consist mainly of Chetek or Kingsley soils that have been cut or graded. Urban land is generally gently sloping.

The Chetek soils are somewhat excessively drained and nearly level to gently sloping. They are on convex crests and sides of hills. These soils have a surface layer of dark grayish brown sandy loam and a subsurface layer of brown loam. The upper part of the subsoil is dark reddish brown gravelly sandy loam, and the lower part is brown gravelly coarse sand. The underlying material is brown and light brown gravelly coarse sand and gravelly sand. A seasonal high water table is below a depth of 6 feet.

The Mahtomedi soils are excessively drained and undulating to very steep. They are on convex tops of ridges and hillsides. The surface layer is very dark gray loamy sand, and the subsurface layer is brown sand. The upper part of the subsoil is dark brown gravelly coarse sand, and the lower part is reddish brown gravelly coarse sand. The underlying material is reddish brown and light reddish brown gravelly sand. A seasonal high water table is below a depth of 6 feet.

Minor soils in this map unit are Udorthents, wet substratum, and Kingsley and Rosholt soils. The Udorthents, wet substratum, consist of filled depressional areas. The Kingsley soils are well drained and formed in loamy glacial till. The Rosholt soils are also well drained. They formed in red gravelly outwash and have a loamy mantle 20 to 40 inches thick over sand and gravel.

Urbanization is taking place rapidly in this map unit. Areas that have not been developed for housing include parks, playgrounds, vacant lots, isolated tracts of wooded land, and yards between and around buildings.

These soils are suited to urban development which is connected with city sewage disposal systems. The main concerns where they are used as building sites are the difficulty of building on steep slopes and the hazard of erosion. There is a danger of pollution of underground water supplies if sanitary facilities are placed on these soils. When they are used for recreational development, soil blowing is the major concern.

3. Urban land-Waukegan-Chetek

Urban land and nearly level to moderately steep, well drained and somewhat excessively drained, medium textured and moderately coarse textured soils; on uplands

This map unit consists of soils that formed in reworked gravelly outwash of mixed origin. Slope is mostly 0 to 12 percent, but ranges to 18 percent. The steeper slopes occur near lakes and drainageways.

This map unit makes up about 15 percent of the total land area of Ramsey County. It is about 40 percent Urban land, 20 percent Waukegan soils, 10 percent Chetek soils, and 30 percent soils of minor extent.

Urban land consists of areas of residential development and is covered by asphalt, concrete, and buildings. Soil materials around building foundations and fill materials used to support structures consist mainly of Waukegan and Chetek soils that have been cut or graded.

The Waukegan soils are well drained and nearly level to moderately sloping. Typically, they have a very dark brown silt loam surface layer. The subsoil is dark yellowish brown silt loam in the upper part and yellowish brown coarse sand in the lower part. The underlying material is light yellowish brown coarse sand. The water table is below a depth of 6 feet throughout the year.

The Chetek soils are somewhat excessively drained and nearly level to moderately steep. They are on convex knolls and crests and sides of hills. The surface layer is dark grayish brown sandy loam about 8 inches thick. The subsoil is about 8 inches thick. The upper part is dark reddish brown gravelly sandy loam. The lower part is brown gravelly sand and gravelly coarse sand. The underlying material is brown and light brown gravelly coarse sand. A seasonal high water table is below a depth of 6 feet.

Minor soils in this map unit are the Udorthents, wet substratum, and well drained Antigo and Rosholt soils. The Udorthents, wet substratum, consist of filled depressional areas. The Antigo soils have a silty mantle underlain by acid, reddish brown gravelly outwash. The Rosholt soils have a 20- to 40-inch loamy mantle underlain by acid, reddish brown gravelly outwash.

About half of this map unit is used for residential areas and urban development. Other uses are parks, playgrounds, vacant lots, isolated tracts of wooded land, and yards around and between buildings.

These soils are well suited to urban development connected with city sewage disposal systems. The main concern when using them as building sites or for sanitary facilities is the difficulty of building on the steeper slopes. When sanitary facilities are placed on the Chetek soils, there is a hazard of pollution of underground water supplies.

Soils formed dominantly in lacustrine sediments

These are mostly soils that formed in silty or loamy lacustrine sediments on glacial lake plains. They are moderately well drained and poorly drained and are level to gently sloping. They formed under mixed hardwood trees and prairie grass.

One map unit in Ramsey County is in this category.

4. Barronett-Grays

Level to gently sloping, poorly drained and moderately well drained, medium textured soils; on glacial lake plains

This map unit consists of soils that formed in silty and loamy lacustrine sediments. Slope ranges from 0 to 6 percent.

This map unit makes up about 1 percent of the total land area of Ramsey County. It is about 60 percent Barronett soils, 20 percent Grays and similar soils, and 20 percent soils of minor extent.

The Barronett soils are poorly drained and level. They occupy slightly depressional lake plains. Typically, they have a black silt loam surface layer and a very dark gray silt loam subsurface layer. The subsoil is dark grayish brown silty clay loam in the upper part and multicolored silt loam in the lower part. The underlying material is also multicolored silt loam. A seasonal high water table occurs at a depth of less than 1 foot.

The Grays soils are moderately well drained and gently sloping. They occupy the higher positions on the landscape. Typically, they have a very dark gray silt loam surface layer, a grayish brown silt loam subsurface layer, a dark brown and brown silty clay loam subsoil, and brown silt loam underlying material. The seasonal high water table is usually at a depth of more than 4 feet.

Less extensive in this map unit are Nessel and Cathro soils. The moderately well drained Nessel soils formed in calcareous glacial till. The very poorly drained Cathro soils formed in organic deposits underlain by loamy material.

Most of this map unit is used for truck crops and sod production. It is well suited to these uses. Urbanization is limited by the seasonal high water table and susceptibility to frost action.

Soils formed dominantly in glacial till

These are mostly upland soils that formed in loamy glacial till, and Urban land. They are well drained and are undulating to steep. They formed under deciduous hardwood forests.

Two of the map units of Ramsey County are in this group.

5. Hayden-Urban land

Undulating to steep, well drained, moderately coarse textured soils and Urban land; on uplands

This map unit consists of soils and Urban land on glacial moraines. Slope ranges from 1 to 24 percent.

This map unit makes up about 21 percent of the total land area of Ramsey County. It is about 30 percent Hayden soils, 28 percent Urban land, and 42 percent soils of minor extent.

The Hayden soils are well drained. They occupy crests of knolls and hills and are undulating to steep. They have a dark grayish brown fine sandy loam surface layer and a grayish brown fine sandy loam subsurface layer. The subsoil is dark yellowish brown and yellowish brown sandy loam, loam, and clay loam. The underlying material is yellowish brown and light olive brown, mottled loam. The seasonal high water table is usually below a depth of 6 feet.

Urban land consists of areas of residential development and is covered by asphalt, concrete, and buildings. Soil materials around building foundations and fill materials used to support structures consist mainly of Hayden or Hayden-like soils that have been cut and graded.

Minor soils in this map unit are Braham, Demontreville, Dundas, Kingsley, and Seelyeville soils. The well drained Braham soils have a sandy surface mantle. The well drained Demontreville soils formed in a sandy mantle and the underlying reddish sandy loam glacial till. Dundas soils are poorly drained and lower in the landscape than other soils. The well drained Kingsley soils formed in reddish sandy loam glacial till. In many areas reddish sandy loam glacial till underlies the Hayden soils and is exposed by excavation for urban development. The very poorly drained Seelyeville soils occupy large level bogs and small depressions and are composed of organic materials.

Urbanization is taking place rapidly in this map unit. Other areas include playgrounds, parks, vacant lots, isolated tracts of grassland and wooded land, and yards around and between buildings. A very small percentage of this map unit is farmed.

If these soils are used for building or sanitary facilities the main concern is the difficulty of building on the steeper slopes. The water table is seasonally high in the depressions and lower lying areas. Moderate volume changes with changes in soil moisture are a concern when buildings, roads, or streets are constructed.

6. Kingsley-Urban land

Undulating to steep, well drained, moderately coarse textured soils and Urban land; on uplands

This map unit consists of Urban land and soils underlain by reddish sandy loam glacial till. It is on ground and terminal moraines. Slope ranges from 2 to 24 percent.

This map unit makes up about 16 percent of the total land area of Ramsey County. It is about 35 percent Kingsley soils, about 30 percent Urban land, and 35 percent soils of minor extent.

The well drained Kingsley soils occupy complex, undulating to steep, convex side slopes. Typically, they have a dark brown sandy loam surface layer, a reddish brown sandy loam subsoil, and reddish brown sandy loam underlying material.

Urban land consists of areas of residential development and is covered by asphalt, concrete, and buildings. Soil materials around building foundations and fill material used to support structures consist mainly of Kingsley or Santiago soils that have been cut or graded. Urban land is commonly on the more gently sloping parts of the landscape.

Minor in this map unit are Udorthents, wet substratum, and Hayden, Chetek, and Santiago soils. The Udorthents, wet substratum, consists of filled depressional areas. The well drained Hayden and Santiago soils occupy positions similar to Kingsley soils. The somewhat excessively drained Chetek soils formed in acid gravelly outwash.

Urban development is taking place rapidly in this map unit. Other areas include parks, playgrounds, vacant lots, isolated tracts of wooded land, and yards around and between buildings. A very small percentage of this map unit is in hobby farms. The main concern if these areas are used as building sites or for sanitary facilities is the steep slope.

Soils formed dominantly in loamy sediments over bedrock

These are soils that formed in loamy sediment over limestone bedrock and Urban land on bedrock-cored terraces. These soils are well drained and level to moderately sloping. They formed under prairie.

One of the map units of Ramsey County is in this category.

7. Urban land-Copaston

Urban land and level to moderately sloping, well drained, medium textured soils; on uplands

This map unit consists of soils that formed in loamy glacial till over hard limestone or sandstone bedrock. Slope ranges from 0 to 8 percent.

This map unit makes up about 3 percent of the land area of Ramsey County. It is about 40 percent Urban land, 30 percent Copaston soils, and 30 percent soils of minor extent.

Urban land consists of areas of residential development and is covered by concrete, asphalt, and buildings. Soil materials around building foundations and fill materials used to support structures consist mainly of Copaston soils that have been cut or graded.

The Copaston soils are well drained and level to moderately sloping. They are in plane and slightly convex positions on rock-cored terraces. Typically, the surface layer is very dark brown loam. The subsoil is dark brown sandy loam in the upper part and dark brown gravelly sandy loam in the lower part. Hard limestone or sandstone bedrock is at a depth of 12 to 20 inches.

Minor soils in this map unit are Udorthents, wet substratum, and Antigo and Kingsley soils. The Udorthents, wet substratum, consist of filled depressional areas. The well drained Antigo soils occupy slightly elevated positions and formed in silty materials underlain by acid, red gravelly outwash. The well drained Kingsley soils also occupy slightly elevated positions but formed in acid, sandy loam glacial till.

More than half of this map unit is occupied by buildings and other structures. Other areas include playgrounds, small parks, vacant lots, small isolated tracts of land, and yards around and between buildings. The shallow depth to bedrock is the main concern in using these areas for building sites or for sanitary facilities. There is a hazard of pollution of ground water where septic tank absorption fields or other sanitary facilities are constructed.

Soils formed dominantly in glacial till or outwash

These are mostly upland soils that formed in glacial till or outwash. They are well drained and excessively drained and are undulating to very steep. They formed under deciduous hardwood forests.

One of the map units of Ramsey County is in this category.

8. Kingsley-Mahtomedi

Undulating to very steep, well drained and excessively drained, moderately coarse textured and coarse textured soils; on uplands

This map unit consists of undulating to very steep soils that formed in reddish sandy loam glacial till or in outwash in areas along the Mississippi River. Slope ranges from 2 to 40 percent.

This map unit occupies about 2 percent of the total land area of Ramsey County. It is about 40 percent Kingsley soils, 25 percent Mahtomedi soils, and 35 percent soils of minor extent.

The Kingsley soils are well drained and undulating to very steep. They occupy hills, irregular areas, and narrow side slopes of escarpments. Typically, they have a dark brown sandy loam surface layer, a reddish brown sandy loam subsoil, and reddish brown sandy loam underlying material.

The Mahtomedi soils are excessively drained and undulating to very steep. They are on convex tops and sides of ridges and hills. The surface layer is very dark gray loamy sand, and the subsurface layer is brown sand. The upper part of the subsoil is dark brown gravelly coarse sand, and the lower part is reddish brown gravelly coarse sand. The underlying material is reddish brown and light reddish brown gravelly sand. A seasonal high water table is below a depth of 6 feet.

Minor soils in this map unit are the Chetek and Rosholt soils. The somewhat excessively drained Chetek soils are similar to Mahtomedi soils but have a 12- to 20-inch loamy mantle over sand and gravel. The well drained Rosholt soils have a 20- to 40-inch loamy mantle over sand and gravel. Bedrock outcrops of limestone and sandstone are on the steeper slopes.

Most of this map unit is in natural woodland. Where urbanization is planned, buildings and roads can be designed to fit into the natural surroundings with as little disturbance as possible. Slope is the main limitation to all uses of the unit.

These soils are well suited to urban development connected with city sewage disposal systems. The main concern if they are used as building sites or for sanitary facilities is the steep slope. If sanitary facilities are placed on the Mahtomedi soils, there is a hazard of pollution of underground water supplies.

Soils formed dominantly in recent alluvium

These are mostly bottom-land soils that formed in recent stratified alluvium and variable textured fill materials on flood plains. These soils are nearly level to very gently sloping and somewhat poorly drained. They formed under hardwood forest on bottom land.

One of the map units of Ramsey County is in this category.

9. Udorthents, wet substratum-Algansee

Nearly level to very gently sloping, variable textured fill material and nearly level, somewhat poorly drained, coarse textured soils; on flood plains

This map unit consists of areas of fill material and of soils that formed in stratified sandy alluvium on the Mississippi River flood plain. Slope ranges from 0 to 4 percent.

This map unit makes up about 5 percent of the total land area of Ramsey County. It is about 50 percent Udorthents, wet substratum, 10 percent Algansee and similar soils, and 40 percent soils of minor extent.

The Udorthents, wet substratum, are nearly level to very gently sloping. They consist of fill material in low areas. The texture of this material is quite variable, but it generally reflects the texture of the adjacent soils. Some of this soil material contains artifacts, some has been dredged from the Mississippi River, and some was used as sanitary landfill and is underlain by refuse. The largest area used as sanitary landfill is at Pig's Eye Island.

The Algansee soils are somewhat poorly drained and very nearly level. Typically, the surface layer is very dark gray loamy sand and is underlain by mottled brownish colored sand. The water table is near the surface during most wet seasons, and flooding occurs in some years.

Minor soils in this map unit are Urban land and Chaska and Kerston soils. Urban land consists of soils covered by asphalt, concrete, and buildings. Most of the urban areas have been constructed on Udorthents, wet substratum. The somewhat poorly drained Chaska soils formed in stratified silty and loamy alluvium. The very poorly drained Kerston soils formed in stratified organic and mineral materials.

Areas of these soils that have not been developed for housing include parks, vacant lots, playgrounds, and woodland. The major concerns if these soils are used as building sites or for sanitary facilities are the hazard of flooding and the seasonal high water table.

Soil maps for detailed planning

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil, a brief description of the soil profile, and a listing of the principal hazards and limitations to be considered in planning management.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Mahtomedi loamy sand, 12 to 25 percent slopes, is one of several phases in the Mahtomedi series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Urban land-Hayden-Kingsley complex is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in a mapped area are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Aquolls and Histosols, ponded, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, gravel is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil descriptions

2—Ostrander silt loam, 0 to 2 percent slopes. This nearly level soil is well drained and occupies broad flats on loess covered uplands. Individual areas are irregular in shape and range from 10 to 60 acres.

Typically, the surface layer is very dark gray silt loam about 14 inches thick. The subsoil is about 32 inches thick. The upper part is dark brown silt loam. The lower part is dark yellowish brown loam. The underlying material is yellowish brown clay loam. In places there is a layer of loamy sand just above the underlying material that is as much as 12 inches thick. In some small areas slope is more than 2 percent.

Included with this soil in mapping are small areas of well drained Baytown, Gale, and Waukegan soils. The Baytown and Gale soils have sandstone bedrock within a depth of 20 to 70 inches. They are on slight rises and knolls. The Waukegan soils formed in silty mantled sand and gravel. They occupy positions similar to the Ostrander soils.

Permeability of the Ostrander soil is moderate. Available water capacity is high. Surface runoff is slow. Natural fertility is medium, and organic matter content is moderate.

Most areas of this soil are farmed. It has good potential for crops, pasture, and hay. Potential is also good for sanitary facilities and building site development.

This soil is well suited to the production of all crops commonly grown in the area. Maintenance of tilth and fertility are the main management needs. Applying manure or commercial fertilizers and growing grasses or legumes in the cropping sequence are ways of maintaining tilth and fertility. Fall tillage, which permits clods to freeze and thaw in winter, produces a seedbed of improved tilth early in spring.

This soil is well suited to hay and pasture. Pastures and hayland can be improved by fertilizing and by seeding adapted grasses and legumes. Proper stocking helps to maintain the desirable, more productive plant species.

This soil has few limitations for sanitary facilities and building site development. Streets, driveways, parking lots, and sidewalks can be damaged by frost action unless placed on more suitable base material. This soil is well suited to septic tank absorption fields. Windbreaks and environmental plantings of grasses, trees, and shrubs are easy to establish.

This soil is in capability class I. It is not placed in a woodland suitability group.

2B—Ostrander silt loam, 2 to 6 percent slopes. This gently sloping soil is well drained and is on sides and shoulders of hills in loess covered uplands. Individual areas range from 5 to 70 acres and are irregular in shape.

Typically, the surface layer is very dark silt loam about 10 inches thick. The subsurface layer is very dark grayish brown silt loam about 4 inches thick. The subsoil is about 22 inches thick. The upper part is dark brown and brown silt loam. The lower part is dark yellowish brown loam. The underlying material is yellowish brown clay loam. In many places the lower part of the subsoil contains a layer of loamy sand up to 12 inches thick. In small areas slope is less than 2 percent or more than 6 percent.

Included in mapping are small areas of well drained Baytown, Gale, Lindstrom, and Waukegan soils. The Baytown and Gale soils have sandstone bedrock at a depth of 20 to 70 inches. The Lindstrom soils, in drainageways, formed in deep colluvial silt. The Waukegan soils formed in silty mantled sand and gravel. The Baytown, Gale, and Waukegan soils occupy similar positions on the landscape to the Ostrander soils.

Permeability of this Ostrander soil is moderate. The available water capacity is high, and surface runoff is medium. Natural fertility is medium, and organic matter content is moderate.

Most areas of this soil are farmed. It has good potential for cultivated crops, pasture, and hay. It has good potential for sanitary facilities and building site development.

Although this soil is subject to erosion, it is well suited to all crops commonly grown in the survey area. Control of erosion and maintenance of tilth and fertility are the main management needs. Where shape and length of slope permit, contour farming or terracing can be used to control erosion. Minimum tillage that leaves crop residue on a rough surface and including forage in the crop rotation help to control erosion and maintain tilth. Fall tillage permits soil clods to freeze and thaw during the winter and produces a seedbed of improved tilth early in spring.

This soil is well suited to pasture and hay crops. These crops effectively control erosion. Overgrazing should be avoided because it increases the risk of erosion. Proper stocking, rotation grazing, fertilization, and weed control help to maintain an adequate cover of desirable and more productive plants.

This soil has few limitations for sanitary facilities and building site development. Erosion should be controlled, both during and immediately following construction. Streets, driveways, parking lots, and sidewalks are subject to damage from frost heaving unless built on more suitable base material. This soil is well suited to septic tank absorption fields. Windbreaks and environmental plantings of trees, shrubs, and grasses are easy to establish on this soil.

This soil is in capability subclass IIe. It is not placed in a woodland suitability group.

2C—Ostrander silt loam, 6 to 12 percent slopes. This moderately sloping soil is well drained. It occurs on sides of hills in loess-covered uplands. Individual areas range from 10 to 60 acres and are irregular in shape.

Typically, the surface layer is very dark gray silt loam about 10 inches thick. The subsoil, about 20 inches thick, is dark yellowish brown silt loam. The underlying material is yellowish brown loam. In some places the original surface layer has been removed by erosion and the present surface layer is dark yellowish brown silt loam. In some small areas slope is less than 6 percent or more than 12 percent.

Included in mapping are a few small areas of well drained Ripon, Baytown, and Lindstrom soils. Both Ripon and Baytown soils have bedrock at a depth of 20 to 40 inches. Ripon soil is underlain by limestone and Baytown soil by sandstone. They occupy landscape positions similar to the Ostrander soil. Lindstrom soils are in drainageways. They formed in deep silty colluvial material.

Permeability of the Ostrander soil is moderate. Available water capacity is high. Surface runoff is medium to rapid. Natural fertility is medium, and organic matter content is moderate.

Most areas of this soil are farmed, though it has only fair potential for cultivated crops. It has good potential for small grains, grasses and legumes, hay, and pasture. The potential for building site development and sanitary facilities is good.

This soil is moderately well suited to cultivated crops, but there is a hazard of erosion where it is cultivated. Terraces and contour farming are needed on long slopes (fig. 5). Minimum tillage that leaves the surface rough and trashy and a rotation that includes forage crops effectively reduce erosion and help to maintain soil tilth. Fall tillage, which permits clods to freeze and thaw in winter, produces a seedbed of improved tilth early in spring. Grassed waterways are needed in some areas to prevent gullying.

This soil is well suited to permanent pasture or hay crops. These are means of controlling erosion. Proper stocking, rotation grazing, fertilization, and weed control reduce the weeds and less productive grasses that invade the pastures. In some instances seeding with approved, more productive plant species is desirable.

This soil is well suited to most building site development and sanitary facilities. Slope is a limitation for some uses. Erosion needs to be controlled both during and immediately following construction. Streets, driveways, parking lots, and sidewalks are subject to damage from frost action unless built on more suitable base material. Slope is a limitation for septic tank absorption fields but can be overcome by special design. Windbreaks and environmental plantings of trees, shrubs, and grasses are easy to establish in this soil.

This soil is in capability subclass IIIe. It is not placed in a woodland suitability group.

7B—Hubbard loamy sand, 1 to 6 percent slopes. This very gently sloping to gently sloping soil is excessively drained. It is on broad flats on outwash terraces along major rivers. Individual areas range from 20 to 200 acres and are irregular in shape.

Typically, the surface soil is very dark gray and dark

Figure 5.—Nursery stock on the contour on Ostrander silt loam, 6 to 12 percent slopes.

brown loamy sand about 20 inches thick. The subsoil is dark brown and brown sand about 15 inches thick. The underlying material is brown sand. In some small areas slope is more than 6 percent.

Included in mapping are small areas of Sparta and Dickman soils. The Dickman soils are somewhat excessively drained and are in shallow depressions. They have sandy loam surface and subsurface layers. The Sparta soils are excessively drained. They formed in fine sand in similar positions on the landscape to the Hubbard soil.

Permeability of the Hubbard soil is rapid. Available water capacity is low. Runoff is medium to slow. Natural fertility and organic matter content are low.

Most areas of this soil are cropland. This soil has poor potential for crops and fair potential for pasture, hay, and woodland. It has good potential for building site development and poor potential for most sanitary facilities.

Because of its droughtiness, this soil is best suited to early maturing crops, such as small grains, that make good use of spring moisture.

Management that increases the organic matter content increases the water holding capacity of the soil. Soil blowing is a hazard, and young plants are easily damaged by blowing sand. Minimum tillage, no-till planting, and green manure crops help to reduce soil blowing and increase the available water capacity of the soil. This soil is well suited to irrigation if an adequate water supply is available. A proper fertilization program is needed to offset the low natural fertility of the soil.

Forage production is limited on this soil due to its low available water capacity and low fertility. It produces fair pasture in early spring and fall, but production is low during the dry summer months and supplemental pastures may be needed. Proper stocking, rotation grazing, and fertilization are needed to maintain a good cover of the more productive plants. This soil erodes easily when overgrazed. Where planting is necessary to improve plant species and potential yield, more drought resistant species are desirable.

This soil has fair suitability for trees. In dry years survival of seedlings is generally low. Furrow planting on the contour or planting in existing vegetation helps to reduce erosion and seedling damage from soil blowing. Competing vegetation should be removed by cultivation, girdling, clearing, or spraying before planting desired tree species.

This soil is well suited to building site development (fig. 6). It is poorly suited to most sanitary facilities. Sidewalls of shallow excavations have poor stability and may cave in. This limitation can be overcome by enlarging the excavation or by installing temporary retaining walls. Septic tank absorption fields function well in this soil, but pollution of ground water is a hazard unless specially designed systems are used. Lawns, trees, and shrubs are difficult to establish on this soil. A topdressing of 12

to 18 inches of loamy material is desirable before seeding grass or laying sod. Frequent watering and fertilizing are necessary to establish and maintain a good vigorous sod cover. This soil is a good source of sand, and a limited amount of gravel can be screened from the sand.

This soil is in capability subclass IVs and woodland suitability group 3s.

7C—Hubbard loamy sand, 6 to 12 percent slopes. This moderately sloping soil is excessively drained. It occupies convex knolls and side slopes on outwash terraces along major rivers. Individual areas range from 5 to 80 acres and are irregular in shape.

Typically, the surface layer is very dark gray loamy sand about 10 inches thick. The subsoil is dark brown loamy sand about 12 inches thick. The underlying material is dark yellowish brown and pale brown stratified coarse and medium sand. In some small areas slope is less than 6 percent or more than 12 percent.

Included in mapping are a few small areas of Dickman soils that are somewhat excessively drained. The Dickman soils have a sandy loam surface layer and subsoil. They are in similar positions on the landscape to the Hubbard soils.

Permeability of the Hubbard soil is rapid. Available water capacity is low. Runoff is medium. Natural fertility and organic matter content are low.

Much of this soil is left idle; however, some is cultivated or planted with trees. This soil has poor potential for crops. It has fair potential as hayland, pasture, and woodland. It has good potential as building sites and poor potential for most sanitary facilities.

This soil is poorly suited to agricultural crops because of its low available water capacity and low natural fertility and the severe hazard of erosion. Slopes are too steep, short, and complex for terracing or contour farming. Soil blowing is a problem, and young plants are easily damaged by blowing sand. Minimum tillage, no-till planting, and green manure crops reduce soil blowing and increase the available water capacity of the soil. This soil is suited to irrigation, but the steep slopes make irrigation difficult. A proper fertilization program is needed to offset the low natural fertility.

This soil is best suited to pasture and hay crops. It produces fair pasture in the spring and fall, but production is very low during dry summer months and supplemental pastures may be needed. Proper stocking, rotation grazing, and fertilization are desirable. This soil erodes easily, and pastures become weedy when overgrazed. Where planting is necessary to improve plant species and potential yield, more drought resistant species are desirable.

This soil has fair suitability for trees. Seedling mortality is moderate due to droughtiness and seedling damage from blowing sand. Seedling survival generally is low in dry years. Furrow planting on the contour or planting in

Figure 6.—Urban development on Hubbard loamy sand. Burkhardt soils are in the swale below the escarpment.

existing vegetation helps reduce erosion and damage to young seedlings by soil blowing. Competing vegetation should be removed by cultivation, girdling, clearing, or spraying before planting desired tree species.

This soil is well suited to building site development and is poorly suited to most sanitary facilities. Sidewalls of shallow excavations have poor stability and may cave in. This limitation can be overcome by enlarging the excavation or by installing temporary retaining walls. Because this soil is noncohesive, gullies can easily develop from increased runoff from roofs and streets. Erosion control is needed during and following construction. Septic tank absorption fields function well in this soil, but unless they are specially designed the pollution of ground water is a hazard. Lawns, trees, and shrubs are difficult to establish. Once established they need frequent watering and fertilizing to maintain a good vigorous sod cover. This soil is a good source of sand, and a limited amount of gravel can be screened from the sand.

This soil is in capability subclass VIs and woodland suitability group 3s.

7D—Hubbard loamy sand, 12 to 18 percent slopes. This moderately steep soil is excessively drained. It is on side slopes on outwash terraces along major rivers. Individual areas range from 10 to 100 acres and are elongated in shape.

Typically, the surface layer is black loamy sand about 7 inches thick. The subsurface layer is brown loamy sand about 5 inches thick. The subsoil is dark brown coarse sand about 8 inches thick. The underlying material is dark yellowish brown and dark brown stratified coarse sand and gravel. In some areas slope is less than 12 percent or more than 18 percent.

Permeability is rapid, and the available water capacity is low. Runoff is rapid. Natural fertility and organic matter content are low. Concrete structures placed in this soil have a moderate corrosion potential.

Most of this soil is idle or planted with trees. This soil has poor potential for crops. It has fair potential as pasture, hayland, and woodland. It has fair potential as building sites and poor potential for sanitary facilities.

This soil is poorly suited to cultivated crops because it has moderately steep slopes, low available water capacity, and low natural fertility and is susceptible to erosion. Machinery can be difficult and unsafe to operate. Slopes are generally too short for contouring or terracing.

The production of pasture is fair in spring and fall but low during the dry summer months. If planting is necessary to improve plant species and potential yield, the more drought resistant varieties are desirable. This soil erodes easily when overgrazed, and overgrazed pastures become weedy. Proper stocking, rotation grazing, fertilization, and weed control help keep the less productive plants from invading the pastures. Haying machinery is difficult to operate and can be unsafe because of the steep slopes.

Seedling survival of trees is low if a dry period follows planting. Planting in furrows on the contour or planting in the existing vegetation or stubble reduces erosion and protects the seedlings from damage by soil blowing. Care must be taken to keep equipment from tipping on the steeper slopes.

This soil is poorly suited to sanitary facilities because it is moderately steep and rapidly permeable. Although slope is a limitation, this soil is suitable as building sites. The sidewalls of shallow excavations have poor stability and may cave in. This limitation may be overcome by enlarging the excavation or by installing temporary retaining walls. Because this soil erodes easily, gullies can result from increased runoff from roofs and streets. Erosion needs to be controlled, both during and after construction. Some areas may need retaining walls and terraces to become desirable homesites.

Moderately steep slope and the hazard of ground water pollution are the limiting factors for septic tank absorption fields. Lawns, trees, and shrubs are difficult to establish and maintain. Frequent watering and fertilizing are necessary to maintain a vigorous sod cover. This soil is a good source of sand, and a limited amount of gravel can be screened from the sand.

This soil is in capability subclass VIs and woodland suitability group 4s.

8—Sparta loamy sand, 0 to 2 percent slopes. This level soil is excessively drained. It is on broad flats on outwash terraces along major rivers. Individual areas range from 30 to 120 acres and are irregular in shape.

Typically, the surface layer is very dark gray loamy sand about 9 inches thick. The subsurface layer is very dark grayish brown and dark brown loamy fine sand about 9 inches thick. The subsoil is brown fine sand about 18 inches thick. The underlying material is yellowish brown and dark yellowish brown fine sand. In some small areas slope is more than 2 percent.

Included in mapping are small areas of Dickman, Hubbard, and Sparta bedrock substratum soils. The Dickman soils are somewhat excessively drained and have a sandy loam surface layer and subsoil. They are in the lower positions on the landscape. The Hubbard soils are excessively drained. They contain medium to coarse sand and a small quantity of gravel. The Sparta bedrock substratum soils have limestone bedrock within a depth of 40 to 60 inches.

Permeability of the Sparta soil is rapid. Surface runoff is slow. The available water holding capacity, natural fertility, and organic matter content are low.

Most areas of this soil are farmed. Potential is poor for row crops and fair for small grains, pasture, and forage crops. It is good for building site development and poor for most sanitary facilities.

The low available water capacity and low natural fertility make this soil poorly suited to corn and soybeans. Early crops are best because they mature before the droughty period. Management that increases the organic matter content of this soil will increase its available water capacity. Soil blowing is a problem, and young plants are

easily damaged by blowing sand. Minimum tillage, no-till planting, cover crops, and field windbreaks help to reduce soil blowing. They also conserve moisture by increasing the available water capacity of the soil. A proper fertilization program is needed to offset the low natural fertility. This soil is well suited to irrigation if an adequate water supply is available.

This soil has fair suitability for pasture and hay crops. It produces fair pasture in spring, but production is low during summer months and supplemental pastures may be needed. When it is used as pasture or hayland, proper stocking is necessary to maintain an adequate vegetative cover. Where planting is necessary to improve stands and the potential yield, more drought resistant species are desirable.

This soil is well suited to building site development. It is poorly suited to most sanitary facilities because it is rapidly permeable. Sidewalls of excavations have poor stability, but caving in can be avoided by enlarging the excavation or by installing temporary retaining walls. Septic tank absorption fields function well in this soil but must be specially designed to prevent the pollution of ground water. Lawns, trees, and shrubs are difficult to establish and maintain on this soil. A topdressing of 12 to 18 inches of loamy material is desirable before laying sod or seeding grass. Frequent watering and fertilizing are necessary to maintain a vigorous sod. This soil is a fair source of sand.

This soil is in capability subclass IVs. It is not placed in a woodland suitability group.

8B—Sparta loamy sand, 2 to 6 percent slopes. This gently sloping soil is excessively drained. It is on outwash terraces along major rivers. Individual areas range from 30 to 200 acres and are irregular in shape.

Typically, the surface layer is black loamy sand about 10 inches thick. The subsurface layer is very dark grayish brown loamy sand about 6 inches thick. The subsoil is dark brown loamy sand about 12 inches thick. The underlying material is brown sand.

Included in mapping are small areas of Dickman, Hubbard, and Sparta bedrock substratum soils. The Dickman soils are somewhat excessively drained. They have a sandy loam surface layer and subsoil and occur in shallow depressions. The Hubbard soils are excessively drained. They contain medium and coarse sand and a small quantity of gravel. The Sparta bedrock substratum soils are similar to other Sparta soils but have limestone bedrock at a depth of 40 to 60 inches.

Permeability of the Sparta soil is rapid. Surface runoff is slow. Natural fertility, organic matter content, and available water capacity are low.

Most areas of this soil are cultivated. Potential is poor for row crops and fair for small grains or forage crops. It is good for building site development and poor for most sanitary facilities.

This soil is poorly suited to corn and soybeans. The hazards of drought and erosion, due to low available water capacity and low natural fertility, are the major limiting factors. Early crops are best because they mature before the droughty period. Management that increases the organic matter content of the soil will increase its water holding capacity. This soil is well suited to irrigation if an adequate water supply is available. Soil blowing is a problem, and young plants are easily damaged by blowing sand. Minimum tillage, no-till planting, cover crops, and field windbreaks help to reduce soil blowing and conserve soil moisture. A proper fertilization program is needed to offset the low natural fertility.

This soil has fair suitability for pasture and hay crops. It is limited by low available water capacity and low natural fertility. It produces fair pasture in spring, but production is low during summer months. When it is used as pasture or hayland, proper stocking is needed to maintain the sod cover. Supplemental pastures may be needed during dry summer months. Where planting is necessary to improve stands and potential yield, more drought resistant species are desirable.

This soil is well suited to building site development. It is poorly suited to most sanitary facilities. Foundations and trenches for utilities are relatively easy to excavate. Sidewalls have poor stability, however, and may cave in. This problem can be overcome by enlarging the excavation or by installing temporary retaining walls. Septic tank absorption fields function well in this soil, but unless they are especially designed the pollution of ground water is a hazard. Lawns, trees, and shrubs are difficult to establish and maintain on this soil. A topdressing of 12 to 18 inches of loamy material is desirable before laying sod or seeding grass. Frequent watering and fertilizing are necessary to maintain a vigorous sod. This soil is a fair source of sand.

This soil is in capability subclass IVs. It is not placed in a woodland suitability group.

8C—Sparta loamy sand, 6 to 15 percent slopes. This moderately sloping to moderately steep soil is excessively drained. It is on side slopes and in undulating areas of outwash terraces along major rivers. Individual areas range from 10 to 150 acres and are irregular in shape.

Typically, the surface layer is very dark gray loamy sand about 11 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 9 inches thick. The subsoil is very dark grayish brown loamy fine sand about 9 inches thick. The underlying material is brown fine sand. In some small areas slope is less than 6 percent or more than 15 percent.

Included in mapping are small areas of Dickman and Hubbard soils. The Dickman soils are somewhat excessively drained and have a sandy loam surface layer and subsoil. They occupy shallow depressions. The Hubbard soils are excessively drained. They formed in medium and coarse sands and a small quantity of gravel.

Permeability of this Sparta soil is rapid. Runoff is medium to rapid. Natural fertility, organic matter content, and available water capacity are low.

Most areas are left idle or are planted to trees. Some areas are cultivated. This soil has poor potential for agriculture. It has good potential as building sites and poor potential for sanitary facilities.

This soil is poorly suited to cultivated crops because of the low available water capacity, low natural fertility, and the hazard of erosion. Early maturing crops, such as small grains, usually make best use of the spring soil moisture. Management that increases the organic matter content of the soil increases its available water capacity. Soil blowing is a problem, and young plants are easily damaged by blowing sand. Minimum tillage, no-till planting, and cover crops reduce soil blowing and conserve soil moisture. This soil is suited to irrigation if an adequate water supply is available. A proper fertilization program is needed to offset the low natural fertility.

This soil is best suited to pasture and hay crops. It produces fair pasture in the spring and fall, but production is very low during the summer months and supplemental pastures may be needed. Overgrazing of pastures should be prevented because this soil erodes easily if overgrazed. Where planting is necessary to improve plant species and potential yields, more drought resistant species are desirable.

This soil is suitable for building site development although slope is a limitation. It is poorly suited to most sanitary facilities. Excavation of this soil is relatively easy, but sidewalls have poor stability and may cave in. This problem can be overcome by enlarging the excavation or by installing temporary retaining walls. Because this soil is noncohesive, gullies can easily be caused by increased runoff from roofs and streets. Erosion needs to be controlled during and immediately following construction. Slope is a limitation for septic tank absorption fields but can be overcome by proper design. Unless specially designed systems are installed, the pollution of ground water in a hazard. Lawns, trees, and shrubs are difficult to establish. Once they are established, frequent watering and fertilizing are necessary to maintain a good vigorous sod cover. This soil is a fair source of sand.

This soil is in capability subclass VIs. It is not placed in a woodland suitability group.

12C—Emmert loamy coarse sand, 3 to 15 percent slopes. This undulating to hilly soil is excessively drained. It is on convex knolls and side slopes on pitted outwash plains. Areas are commonly 5 to 40 acres and irregular in shape.

Typically, the surface layer is dark brown loamy coarse sand about 9 inches thick. The subsoil is about 27 inches thick. The upper part is dark brown yellowish sand. The lower part is dark yellowish brown and yellowish brown gravelly coarse sand. The underlying material is yellowish brown gravelly coarse sand that is more than 35 percent coarse fragments. In some areas the underlying material is less than 35 percent coarse fragments. In some areas slope is less than 3 percent or more than 15 percent.

Included in some of the mapped delineations are small areas of Chetek and Kingsley soils. Both these soils are in similar positions on the landscape to the Emmert soils. Chetek soils have a thin loamy mantle. Kingsley soils formed in pockets of red loamy till, unlike the Emmert soil, which formed in sandy and gravelly outwash.

The Emmert soil has very rapid permeability. Available water capacity is very low. Surface runoff is medium. Organic matter content and natural fertility are low.

Many areas of this soil are used for urban development. Other areas are used for crops, pasture, hay, or woodland. This soil has poor potential for crops. It has fair potential for pasture, hay, and trees. It has good to fair potential as building sites and poor potential for most sanitary facilities.

Because of the very low available water capacity and steep slope, the hazards of drought and erosion are severe. The soil is, therefore, very poorly suited to crops. It generally is not suited to irrigation because of the slope, very low available water capacity, and high susceptibility to nutrient loss through leaching. Gullies should be shaped and seeded to grass for use as waterways.

This soil produces fair pasture and hay early in spring and fall, but production is low during dry summer months. Proper stocking is needed because this soil erodes easily if overgrazed. Overgrazing also allows weeds and the less productive grasses to invade the pasture.

This soil has fair suitability for trees. Seedling mortality can be expected to be high if a dry season follows planting. Furrow planting on the contour or planting in existing vegetative cover reduces erosion and protects new seedlings from damage by blowing sand. Diversions or grassed waterways may be necessary to divert water from higher slopes and prevent gully erosion.

This soil is suitable as building sites although slope is a moderate to severe limitation. It is poorly suited to most sanitary facilities. Because it is noncohesive, slopes and embankments are difficult to stabilize with vegetative cover. This soil is relatively easy to excavate, but sidewalls have poor stability and may cave in. This can be prevented with temporary retaining walls.

Septic tank absorption fields work well in this soil but unless specially designed systems are installed, there is a hazard of pollution of underground water. Vegetation is difficult to establish and maintain. Frequent watering and fertilizing are necessary to maintain a vigorous sod cover. Topdressing with 12 to 18 inches of loamy material is desirable before seeding grass or laying sod. This soil is a good source of sand and gravel, a resource that should be considered before developing the soil for other uses.

This soil is in capability subclass VIs and woodland suitability group 3s.

12D—Emmert gravelly loamy coarse sand, 15 to 25 percent slopes. This hilly to steep soil is excessively

drained. It occupies side slopes and hills on pitted outwash plains and terminal moraines. Individual areas are irregular in shape and range from 3 to 20 acres.

Typically, the surface layer is dark grayish brown gravelly loamy coarse sand about 6 inches thick. The subsoil is brown gravelly coarse sand about 18 inches thick. The underlying material is reddish brown gravelly coarse sand that is more than 35 percent coarse fragments. In some areas the underlying material is less than 35 percent coarse fragments. Also, in some areas slope is less than 15 percent or more than 25 percent.

Included with this soil in mapping are small areas of Chetek and Kingsley soils. Chetek soils have a thin loamy mantle and are underlain by reddish brown sand and gravel. Kingsley soils formed in pockets of red loamy till, but the Emmert soil formed in sandy and gravelly outwash. The included soils occupy positions on the landscape similar to the Emmert soils. They make up 2 to 10 percent of the acreage.

This Emmert soil has very rapid permeability. Available water capacity is very low. Surface runoff is rapid. Organic matter content and natural fertility are low.

Most areas are wooded or are in grass. This soil has poor potential for crops and fair potential for pasture. It has fair to poor potential for trees. It has poor potential for sanitary facilities and fair potential as building sites.

Because the hazards of drought and erosion are severe, this soil generally is not used for cultivated crops. Gullies should be shaped and seeded to grass for use as waterways. Some gullies may need to be stabilized before grasses can be grown. If these soils are used for pasture or hay, good management is needed to maintain the sod cover. Overgrazing of pastures should be prevented, because the soil erodes easily when overgrazed.

This soil has fair suitability for trees. Seedling mortality can be expected to be high if a dry year follows planting. Drought is the major limiting factor. Competition from undesired vegetation is moderate and may delay, but generally does not prevent, the establishment of a normal, fully-stocked stand of desirable species. Because erosion is a hazard, soil loss should be kept to a minimum during site preparation. Heavy equipment should be used only on the milder slopes.

This soil is suited to building site development although steep slopes are a severe limitation. It is poorly suited to sanitary facilities. It is easily eroded, and gullies develop where the soil is disturbed and left bare. Steep slopes and embankments are difficult to stabilize with vegetative cover. Retaining walls and land shaping may be needed to make desirable homesites. There is a hazard of sidewalls caving when this soil is excavated, but this can be prevented with temporary retaining walls.

This soil is poorly suited to septic tank absorption fields because of the steep slopes and the hazard of contamination of ground water. This soil is a good source of sand and gravel, a resource that should be considered before developing this soil for other uses.

This soil is in capability subclass VIIs and woodland suitability group 4s.

49—Antigo silt loam, 0 to 2 percent slopes. This nearly level soil is well drained. It occupies broad flats on glacial outwash plains. Mapped areas are irregular in shape and commonly range from about 5 to 50 acres.

Typically, this soil has a very dark gray silt loam surface layer about 9 inches thick. The subsurface layer, about 4 inches thick, is dark grayish brown silt loam. The subsoil is about 25 inches thick. The upper part is dark brown silt loam. The middle part is dark brown and dark yellowish brown silt loam. The lower part is yellowish brown loam. The underlying material is light yellowish brown stratified coarse sand and gravel. In some small areas slope is more than 2 percent. In the southern part of the survey area the surface layer is thicker and darker colored than typical.

Included with this soil in mapping are small areas of Chetek, Rosholt, Campia, Brill, Poskin, and Barronett sandy substratum soils. The Chetek soil is excessively drained and has a 12- to 20-inch loamy mantle over reddish brown sand and gravel. The Rosholt soil is well drained and has a 20- to 40-inch loamy mantle over reddish brown sand and gravel. The Campia soil is well drained and is silty to a depth of 60 inches or more. The moderately well drained Brill soil, the somewhat poorly drained Poskin soil, and the poorly drained Barronett sandy substratum soils occupy small drainageways and depressions.

This Antigo soil has moderate permeability in the upper part of the profile and very rapid permeability in the sandy underlying material. Available water capacity is moderate. Surface runoff is slow. Natural fertility is medium, and organic matter content is moderate.

Most areas of this soil are cropland. Many areas are or have been converted to urban uses. Potential is good for crops, pasture, hay, and trees. It is good for building site development but poor for most sanitary facilities.

This soil is well suited to corn, soybeans, small grains, and hay. There is little hazard of water erosion. Returning crop residue to the soil helps to conserve moisture and improve fertility and tilth. Response is good to lime and fertilizer. Droughtiness may be a problem because of the moderate available water capacity. In many areas where cultured sod is grown, sprinkling systems are used to maintain an adequate available moisture supply (fig. 7).

This soil is well suited to pasture and hay crops. Supplemental pasture may be needed during the dry summer months, however, the more drought-resistant seeding mixtures produce more forage during the warm summer months than other varieties. Proper stocking, pasture rotations, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. Trees and cuttings survive and grow well if competing vegetation is con-

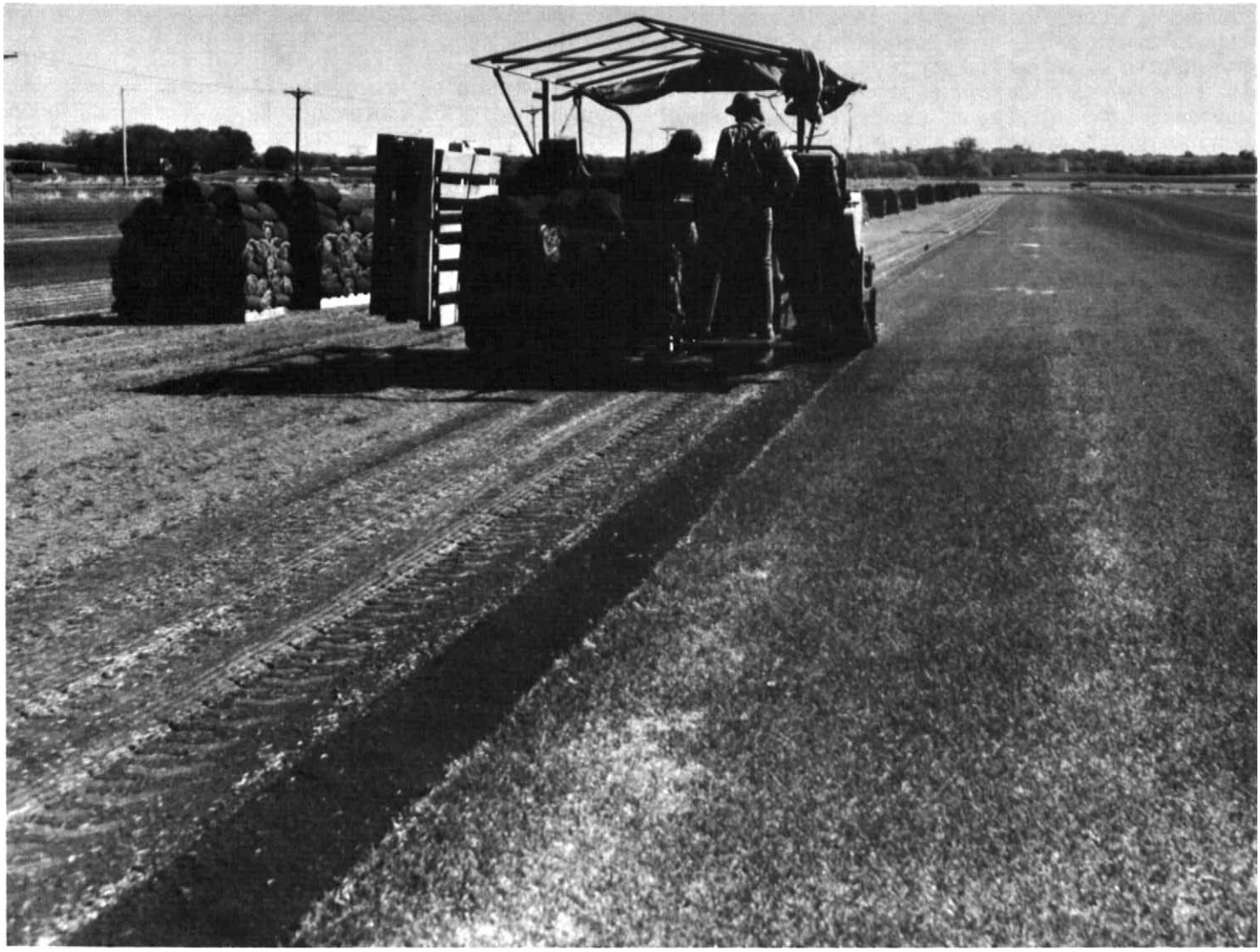

Figure 7.—Harvesting sod on Antigo silt loam, 0 to 2 percent slopes.

trolled. Control can be accomplished by spraying, cutting, or girdling the trees and by cultivation.

This soil has fair suitability as building sites and poor suitability for most sanitary facilities. Soil strength is low in the silty mantle but is high in the underlying sandy material. Susceptibility to frost heave is moderate. Special precautions may be needed when installing roads, streets, sidewalks, and parking areas to prevent damage from frost heave. Sidewalls in the sandy underlying material have poor stability and may cave in during excavating for foundations or installation of underground utilities. This can easily be prevented with temporary retaining walls. Septic tank absorption fields function well in this soil. They must be specially designed, however, because the underlying material is rapidly permeable and there is a hazard of pollution of ground water. Lawns, trees, and shrubs are generally easy to establish and maintain. This soil is a good source of sand and gravel for construction.

This soil is in capability subclass IIs and woodland suitability group 2o.

49B—Antigo silt loam, 2 to 6 percent slopes. This undulating soil is well drained. It occupies low knolls and broad undulating flats intermingled with depressions on glacial outwash plains. Mapped areas are 10 to 50 acres and irregular in shape.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsurface layer is grayish brown and dark grayish brown silt loam about 2

inches thick. The subsoil is about 22 inches thick. The upper part is brown silt loam. The middle part is reddish brown silt loam. The lower part is reddish brown loam. The underlying material is reddish brown and dark reddish brown gravelly sand and gravelly coarse sand. In some delineations slope is less than 2 percent or more than 6 percent. In the southern part of the survey area the surface layer is thicker and darker colored than typical.

Included with this soil in mapping are small areas of Chetek, Rosholt, Campia, Brill, Poskin, and Barronett sandy substratum soils. Chetek and Rosholt soils have less clay in the subsoil than the Antigo soil. Campia soils have silty materials to a depth of 60 inches or more. The Chetek, Rosholt, and Campia soils occupy positions on the landscape similar to the Antigo soils and make up 2 to 5 percent of the delineation. The moderately well drained Brill soils, the somewhat poorly drained Poskin soils, and the poorly drained Barronett soils occupy small drainageways and depressions and make up less than 5 percent of the delineation.

This Antigo soil has moderate permeability in the silty upper part of the profile and very rapid permeability in the sandy underlying material. The available water capacity is moderate. Surface runoff is medium. Natural fertility is medium, and the organic matter content is moderate.

Most areas of this soil are farmed, but many areas are rapidly being converted to urban uses. This soil has good potential for crops and grass and legume hay or pasture. It has good potential as building sites. It has poor potential for most sanitary facilities.

This soil is well suited to corn, soybeans, small grains, and grass and legume hay and pasture. If the soil is cultivated, there is a hazard of erosion unless adequate conservation practices are used. Most areas are too small or too irregular in shape or slopes are too short for terracing or contour farming. Minimum tillage and forage crops in the rotation also help to control erosion. In drier years drought may be a problem due to the moderate available water capacity of the soil.

This soil is well suited to pasture and hay production. Overgrazing should be avoided because it increases the risk of erosion. Proper stocking, rotation grazing, and weed control will help keep a good vegetative cover on the soil.

This soil is well suited to trees, and a few small areas remain in woodlots of northern hardwoods. Seedlings and cuttings survive and grow well if competing vegetation is controlled. Control can be accomplished by spraying, cutting, or girdling trees and by cultivation.

This soil has fair suitability as building sites and poor suitability for most sanitary facilities. Soil strength is low in the silty mantle but is high in the sandy underlying material. Susceptibility to frost heave is moderate. Special precautions may be needed when installing roads, streets, sidewalks, and parking areas to prevent damage from frost heave. Sidewalls in the sandy underlying material have poor stability and may cave in during excavation or installation of underground utilities. This can be prevented with temporary retaining walls.

Septic tank absorption fields function well in this soil, but unless specially designed systems are installed, there is a hazard of pollution of underground water supplies and nearby lakes and streams. Lawns, trees, and shrubs are generally easy to establish and maintain. This soil is a good source of sand and gravel for construction.

This soil is in capability subclass IIe and woodland suitability group 2o.

49C—Antigo silt loam, 6 to 12 percent slopes. This gently rolling soil is well drained. It is on crests and sides of hills on pitted outwash plains. Mapped areas are commonly 15 to 50 acres and irregular in shape.

Typically, the surface layer is very dark grayish brown silt loam about 2 inches thick. The subsurface layer is dark grayish brown silt loam about 11 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown silt loam. The lower part is dark brown loamy sand. The underlying material is dark brown gravelly sand. In some areas slope is less than 6 percent or more than 12 percent. In the southern part of the survey area the surface layer is thicker and darker colored than typical.

Included with this soil in mapping are small areas of Chetek, Rosholt, Campia, Brill, Poskin, and Barronett sandy substratum soils. The Chetek soil is excessively drained and has a 12- to 20-inch loamy mantle over reddish brown sand and gravel. The Rosholt soil is well drained and has a 20- to 40-inch loamy mantle over reddish brown sand and gravel. The Campia soil is well drained and has silty material to a depth of 60 inches or more. The Chetek, Rosholt, and Campia soils occupy positions on the landscape similar to the Antigo soils and make up 2 to 10 percent of the delineations. The moderately well drained, less sloping Brill soil occupies lower positions on the landscape. The somewhat poorly drained Poskin soil and the poorly drained Barronett sandy substratum soil occupy small drainageways and depressions. The Brill, Poskin, and Barronett sandy substratum soils make up less than 5 percent of the map unit.

This Antigo soil has moderate permeability in the silty upper part of the profile and very rapid permeability in the sandy underlying material. The available water capacity is moderate. Surface runoff is medium to rapid. Natural fertility is medium, and the organic matter content is moderate.

Most areas of this soil are farmed, but many areas are developed for urban uses. This soil has good potential for cropland and grass and legume hay and pasture. It has good potential for trees. It has fair potential as building sites. It has poor potential for most sanitary facilities.

This soil has fair suitability for all the crops commonly grown in the survey area. It warms early in spring and

can be worked fairly soon after rainfall. Where cultivated row crops are grown, the hazard of erosion is severe. Stripcropping and mulch tillage should be employed on the steeper slopes. Slopes generally are too irregular or too short or the areas are too small for contour farming or terracing. Minimum tillage or a crop rotation containing forage crops also helps to control erosion. Drought may be a problem because of the moderate available water capacity. Applying manure, growing grasses and legumes, and fertilization control erosion and improve tilth and fertility.

The use of permanent pasture and hay is an effective means of controlling erosion. In drier years supplemental pasture may be needed. Proper stocking, rotation grazing, and brush control help to keep the pasture and soil in good condition. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to trees. Tree seedlings and cuttings survive and grow well if competing vegetation is controlled. Control can be accomplished by spraying, cutting, or girdling trees and by cultivation. Erosion is a hazard, and a soil cover should be maintained whenever possible.

This soil is suited to building site development although slope is a moderate limitation. It is poorly suited to most sanitary facilities. Soil strength is low in the silty mantle but is high in the sandy underlying material. Susceptibility to frost heave is moderate. Special precautions may be needed when installing roads, streets, sidewalks, and parking areas to prevent damage from frost heave. Sidewalls have poor stability in the sandy underlying material and may cave in during excavation for foundations or installation of underground utilities. This can be prevented with temporary retaining walls.

Slope is a limitation for septic tank absorption fields but can be overcome by proper design. Specially designed systems are needed to overcome the hazard of pollution of underground water supplies and nearby lakes and streams. Lawns, trees, and shrubs are generally easy to establish and maintain on this soil. This soil is a good source of sand and gravel for construction.

This soil is in capability subclass IIIe and woodland suitability group 2o.

49D—Antigo silt loam, 12 to 18 percent slopes. This is a hilly, well drained soil on crests and sides of hills on pitted outwash plains. Individual areas are irregular in shape and range from 3 to 50 acres.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is grayish brown silt loam about 4 inches thick. The subsoil is dark yellowish brown silt loam about 12 inches thick. The underlying material is brown coarse sand and gravel. In small areas slope is less than 12 percent. In the southern part of the survey area the surface layer is thicker and darker colored than typical.

Included with this soil in mapping are small areas of Chetek and Mahtomedi soils that do not have a silty mantle. The Mahtomedi soils are also predominantly sandy. Small areas of moderately well drained Brill soils are included in the lower, less sloping positions on the landscape.

This Antigo soil has moderate permeability in the silty mantle and very rapid permeability in the underlying material. Surface runoff is rapid. The available water capacity is moderate. Natural fertility is medium, and the organic matter content is moderate.

Most areas of this soil are used for permanent pasture or woodland. Some areas are developed for urban uses. This soil has poor potential for row crops. It has fair potential for small grains or forage crops. It has good potential for woodland. It has poor potential for sanitary facilities and fair potential as building sites.

When farmed, this soil is better suited to small grains or hay than to row crops. The hazard of erosion is severe and the operation of modern farm machinery is difficult on the steep slopes. Slopes are generally too short or too steep for terracing. Erosion can be controlled by farming across the slope, contour stripcropping, minimum tillage, and planting a high percentage of forage crops. Droughtiness is usually a problem because of the moderate available water capacity and the rapid runoff.

The soil has fair suitability for pasture and hay crops. It erodes easily when overgrazed. Proper stocking, rotation grazing, fertilization, and weed control help to keep the pasture and soil in good condition. The use of this soil for pasture or hay is effective in controlling erosion, provided it is not overgrazed.

This soil is well suited to trees. Because plant competition is moderate to severe, sites need to be prepared and weeded to insure the success of plantings. Seedling mortality is slight. Equipment limitations and the hazard of erosion are severe. Precautions must be taken to keep equipment from tipping on the steeper slopes. A protective cover of vegetation is needed on this soil.

This soil is suited to building site development although slope is a severe limitation. It is poorly suited to sanitary facilities. Erosion control is necessary during construction. Soil strength is low in the silty mantle but is high in the sandy underlying material. Susceptibility to frost heave is moderate. Special precautions may be needed when installing roads, streets, sidewalks, and parking areas to prevent damage from frost heave. Sidewalls in the sandy underlying material have poor stability and may cave in during excavation for foundations or installation of underground utilities. This can be prevented by temporary retaining walls.

This soil is poorly suited to septic tank absorption fields because of the steepness of slope and the hazard of polluting nearby water supplies. Lawns, trees, and shrubs are generally easy to establish. This soil is a good source of sand and gravel for construction.

This soil is in capability subclass IVe and woodland suitability group 2r.

75—Bluffton loam. This soil is level and very poorly drained. It occupies slightly concave drainageways and depressions on ground moraines. Mapped areas are commonly 5 to 80 acres and irregular in shape. This soil is subject to frequent flooding by runoff from adjacent steeper soils.

Typically, the surface soil is black loam about 19 inches thick. The subsoil is dark gray, mottled fine sandy loam about 3 inches thick. The underlying material is gray and light olive gray, mottled calcareous loamy till. In some places the surface soil is thicker than 19 inches.

Included in mapping are small areas of Dundas, Webster, and Cathro soils. The Dundas and Webster soils are poorly drained and are slightly higher on the landscape than the Bluffton soil. The Cathro soils are very poorly drained and have a muck surface layer. They occupy depressional areas. These included soils generally make up less than 5 percent of the mapped area.

The Bluffton soil has moderately slow permeability. Available water capacity, organic matter content, and natural fertility are high. Runoff from adjacent soils ponds on this soil. In undrained areas a seasonal high water table is commonly less than 2 feet from the surface during wetter seasons.

Some areas of this soil are drained and used for crops. If adequately drained, this soil has good potential for crops, pasture, and hay. It has fair potential for woodland. This soil has poor potential for sanitary facilities and as building sites. It has good potential for wetland wildlife habitat.

Although this soil is well suited to cultivated crops, if it can be artificially drained, there are not adequate drainage outlets in many places. Where adequately drained this soil is farmed and managed along with the surrounding soils. In years of intensive rainfall crops can be damaged or destroyed by ponding.

If drained, this soil has good potential for pasture. Grazing when the soil is too wet will cause surface compaction and poor tilth. Proper stocking, pasture rotation, and timely deferment of grazing are desirable to maintain an adequate cover of productive plants. This soil is a good site for stock watering pits.

Plant competition is severe in wooded areas. It can, however, be controlled by cultivation, girdling, clearing, or spraying.

This soil is well suited to wetland wildlife habitat. If the watershed can supply enough water, it is favorable for pond reservoirs. Wetland food and cover plants are well suited to this soil.

This soil is poorly suited to sanitary facilities and building site development because of wetness. If it is used for building, drainage is needed or foundations should be placed above the water table. This soil has low strength and is highly susceptible to frost heave. Streets, driveways, foundations, and parking lots are subject to structural damage unless they are carefully designed. This soil is generally not suited to septic tank absorption fields unless they are specially designed to overcome limitations imposed by the seasonal high water table and the moderately slow permeability. Lawns, trees, and shrubs are easy to establish if this soil is drained.

This soil is in capability subclass IIIw and woodland suitability group 3w.

100B—Copaston loam, 0 to 6 percent slopes. This level to gently sloping soil is well drained. It occupies plane or slightly convex areas on bedrock-cored terraces and benches. This soil formed in a thin 12- to 20-inch mantle of loamy glacial drift over bedrock. Mapped areas range from about 5 to 50 acres and are irregular in shape.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsoil is dark brown sandy loam and gravelly sandy loam about 10 inches thick. Brownish-yellow sandstone is at a depth of 18 inches. In some areas the underlying bedrock is limestone.

Included in some mapped areas of Grey Cloud Island Township in Washington County are soils that have a thicker loamy mantle than typical. In other areas, mostly in the vicinity of William O'Brien State Park, a thin layer of residuum is between the loamy mantle and the bedrock or the loamy mantle is less than 12 inches thick.

The Copaston soil has moderate permeability. The available water capacity is very low due to the shallowness of the soil. Surface runoff is slow because of the gentle slopes. Natural fertility is low, and organic matter content is moderate.

Most areas of this soil are in permanent pasture or hay crops. Some areas are used for parks. This soil has fair potential for cultivated crops and grass and legume pasture and hay. It has poor potential for sanitary facilities and fair potential as building sites.

This soil is better suited to small grains than to corn and soybeans. The rooting zone is restricted by the shallow depth to the underlying bedrock. This soil is subject to droughtiness during most summers because of the very low available water capacity. Erosion is a slight hazard on the steeper slopes. Minimum tillage or crop rotations containing forage crops help to reduce erosion, conserve moisture, and maintain tilth.

This soil has fair suitability for pasture and hay crops. It provides good pasture in spring and fall and fair to poor pasture in summer because of its low available water capacity. Proper stocking, rotation grazing, fertilization, and weed control help to keep the pasture and soil in good condition. The use of this soil for pasture or hay is also an effective means of controlling erosion.

This soil is suited to building site development although it is severely limited by the shallow depth to the underlying bedrock. In most areas the underlying bedrock is very hard or cemented and large machinery is required for bedrock excavation.

This soil is poorly suited to septic tank absorption fields because of the shallowness of the underlying bedrock. Pollution of ground water is a hazard because effluent seeps through the fissures and cracks in the

bedrock. Grasses, trees, and shrubs are generally easy to establish. It may be desirable to topdress this soil with 12 to 18 inches of loamy material to provide a deeper rooting zone for plants. Additional watering may be necessary during dry periods.

This soil is in capability subclass IIIe. It is not placed in a woodland suitability group.

100C—Copaston loam, 6 to 12 percent slopes. This moderately sloping soil is well drained. It formed in 12 to 20 inches of loamy glacial till over limestone bedrock on uplands and terraces. Individual areas are irregular in shape and range from 5 to 25 acres.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsoil is dark brown and brown sandy loam about 8 inches thick. Limestone bedrock is at a depth of 17 inches. In some areas sandstone is the underlying bedrock. In some areas a thin layer of residuum occurs between the loamy mantle and the bedrock. In some areas the loamy mantle is less than 12 inches or more than 20 inches thick.

Included in some mapped areas, primarily in Grey Cloud Island Township in Washington County, are soils that have a thicker loamy mantle than typical. In other areas a thin layer of residuum is between the loamy mantle and the bedrock or the loamy mantle is less than 12 inches thick. These areas are mostly in the vicinity of William O'Brien State Park.

This Copaston soil has moderate permeability. Surface runoff is medium. The available water capacity is very low due to the shallow depth of the soil. Natural fertility is low, and organic matter content is moderate.

Most areas of this soil are in permanent pasture or hay crops. Some areas are used for parks. This soil has fair potential for grass and legume pasture and hay. It has poor potential for cultivated crops. It has poor potential for sanitary facilities and fair potential as building sites.

This soil is better suited to small grains than to corn and soybeans. The rooting zone is restricted by the shallow depth to the underlying bedrock. This soil is subject to droughtiness during most summers because of the very low available water capacity. Erosion is a slight hazard on the steeper slopes. Minimum tillage or crop rotations containing forage crops help to reduce erosion, conserve moisture, and maintain tilth.

This soil has fair suitability for pasture and hay crops. It provides good pasture in spring and fall and fair to poor pasture in summer because of its low available water capacity. Proper stocking, rotation grazing, fertilization, and weed control help to keep the pasture and soil in good condition. The use of this soil for pasture or hay is also an effective means of controlling erosion.

This soil is suited to building site development although it is severely limited by the shallow depth to the underlying bedrock. In most areas the underlying bedrock is very hard or cemented and large machinery is required for bedrock excavations.

This soil is poorly suited to septic tank absorption fields because of shallowness to bedrock. Pollution of ground water is a hazard because water seeps through fissures and cracks in the bedrock. Erosion needs to be controlled during construction on this soil. Lawns, trees, and shrubs are generally easy to establish, but additional watering may be necessary during dry periods. It may be desirable to topdress this soil with 12 to 18 inches of loamy material to provide a deeper rooting zone for plants.

This soil is in capability subclass IVe. It is not placed in a woodland suitability group.

113—Webster loam. This soil is level and poorly drained. It is in low areas and small drainageways. Slopes are slightly concave. Individual areas are irregular in shape and cover 5 to 30 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer, about 8 inches thick, is black and very dark gray clay loam. The subsoil is olive gray, calcareous, mottled loam. The underlying material is olive gray and gray, calcareous, mottled sandy clay loam. In places the underlying material is fine sandy loam that has strata of sand.

Included with this soil in mapping are small areas of poorly drained Dundas soils that occupy similar positions on the landscape but have a thinner surface layer and less clay throughout. There are also some areas of very poorly drained Bluffton soils in small, wet depressions.

Permeability of the Webster soil is moderately slow. Surface runoff is slow. Available water capacity, natural fertility, and organic matter content are high. A seasonal high water table is 1 to 3 feet below the surface during wet seasons.

Most areas of this soil are artificially drained and farmed. This soil has good potential for crops, hay, and pasture. It has poor potential for sanitary facilities and as building sites.

If artificially drained, this soil is well suited to crops. It warms up slowly in spring and dries off slowly after rains. Water stands on the surface for short periods. Drainage systems are needed to remove surface water and lower the water table to allow proper root development. Maintenance of tilth is important to the management of this soil. Fall tillage permits freezing and thawing of the soil during winter, thus breaking clods and providing a spring seedbed of improved tilth.

Some undrained areas of this soil are in permanent pasture. Proper stocking, rotation grazing, fertilization, and weed control help keep the pasture in good grazing condition. This soil holds moisture well throughout the growing season. Grazing should be delayed in early spring and after heavy rains to prevent pasture damage and soil compaction.

Because of wetness this soil is poorly suited as building sites. Susceptibility to frost action is high. Moderate volume changes occur with changes in soil moisture. Streets, roads, and sidewalks tend to heave and crack if not carefully constructed. Soil strength is low. If this soil is to be used for building, tile drainage needs to be

placed around foundation footings or the foundations should be placed above the water level. The soil is poorly suited for septic tank absorption fields because of the seasonal high water table and moderately slow permeability. Sod, trees, and shrubs are easy to establish on this soil.

This soil is in capability subclass IIw. It is not placed in a woodland suitability group.

120—Brill silt loam. This is a very gently sloping, moderately well drained soil. It is in slightly concave positions in drainageways and depressions. Individual areas are irregular in shape and range from 5 to 30 acres.

Typically, the surface layer is very dark gray silt loam about 3 inches thick, and the subsurface layer is grayish brown silt loam about 8 inches thick. The subsoil, about 24 inches thick, is dark brown and brown silt loam. The underlying material is reddish brown and strong brown stratified gravelly coarse sand, loamy fine sand, and fine sand.

Included with this soil in mapping are small areas of Antigo and Barronett soils. The well drained Antigo soils are on steeper side slopes, and the poorly drained Barronett sandy substratum soils are in wet depressions and drainageways.

This Brill soil has moderate permeability in the silty upper part of the profile and very rapid permeability in the underlying material. Surface runoff is medium to slow. The available water capacity and organic matter content are moderate. Natural fertility is medium. A seasonal high water table is at a depth of 3 to 5 feet.

Most areas of this soil are farmed. This soil has good potential for crops, pasture, hay, and trees. It has poor potential for sanitary facilities and fair potential as building sites.

This soil is well suited to all crops commonly grown in the survey area. The main limitation is moderate available water capacity. Maintaining soil tilth generally is not a problem, but all crop residues should be returned to the soil to improve available water capacity and fertility. This soil is suited to irrigation if water is available.

This soil is well suited to pasture and hay crops. Proper stocking, rotation grazing, weed control, and fertilizing are necessary to maintain desirable and productive forage species. Because of the moderate available water capacity, supplemental pasture may be needed during dry summer months. When alfalfa is planted, either alone or with other grasses, liming may be necessary.

This soil is suitable for trees, and a few small areas remain in woodlots. Seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by cultivation, girdling, clearing, or spraying before planting.

This soil is suited to building site development although a seasonal high water table is at a depth of 3 to 5 feet during wet seasons. The use of drainage tile around foundations will help prevent wet basements. Caving of sidewalls is a problem during excavation. This can be prevented with temporary retaining walls. This soil is poorly suited to sanitary facilities. Septic tank absorption fields may fail in the spring because of the seasonal high water table unless they are specially designed. Lawns, trees, and shrubs are generally easy to establish and maintain on this soil.

This soil is in capability subclass IIs and woodland suitability group 2o.

123—Dundas fine sandy loam. This soil is nearly level and poorly drained. It is in plane and slightly convex positions on ground moraines. Delineations are commonly irregular in shape and cover 5 to 30 acres.

Typically, the surface layer is very dark gray fine sandy loam about 9 inches thick. The subsurface layer is grayish brown, mottled sandy clay loam about 4 inches thick. The subsoil is grayish brown, mottled sandy clay loam about 32 inches thick. The underlying material is grayish brown, mottled loam. In some small areas the surface layer is loamy sand or coarser material. In other areas it is darker and thicker than typical.

Included with this soil in mapping are small areas of Hayden, Bluffton, and Cathro soils. The well drained Hayden soils occupy higher positions on the landscape. The very poorly drained Bluffton and Cathro soils are in lower depressional areas. The Cathro soils have a mantle of organic soil over loam.

The Dundas soil has moderately slow permeability. Surface runoff is slow. The available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas of this soil are used for farming. It has good potential for crops, hay, and pasture if drained. This soil has fair potential for woodland. It has poor potential for sanitary facilities and as building sites.

If properly drained and managed, this soil is well suited to most crops commonly grown in the area. This soil dries slowly. If it is tilled in fall, a seedbed can be prepared earlier the following spring. Returning crop residues to the soil and using grasses and legumes in the crop rotation help maintain soil tilth.

This soil is well suited to pasture because it holds moisture well throughout the growing season. Some pastures that are partly wooded and brushy provide poor grazing. Clearing these areas and reseeding to tall grasses and legumes, such as bromegrass and alfalfa or bluegrass, improves production. Proper stocking, rotation grazing, weed control, and fertilization are desirable to maintain an adequate cover of productive plants.

This soil has only fair suitability for trees. Plant competition is severe; however, seedlings survive and grow well if competing vegetation is controlled or removed. Plant survival depends mainly on the natural water table, which is at a depth of 1 to 3 feet during wet periods.

This soil is poorly suited as building sites and for sanitary facilities because of wetness. Building founda-

tions may be damaged by frost action and by shrinking and swelling of this soil. Streets, roads, sidewalks, and parking lots heave and crack unless designed to withstand the frost action. Soil strength for supporting buildings is low. If this soil is used for building, it should be artificially drained to lower the water table or foundations should be built on fill material above the water table. Septic tank absorption fields function poorly in this soil because of wetness and moderately slow permeability. It is easy to establish sod, trees, and shrubs on this soil. Seedbeds for lawns are often hard to prepare, however, because of surface compaction and poor tilth.

This soil is in capability subclass IIw and woodland suitability group 3w.

132B—Hayden fine sandy loam, 2 to 6 percent slopes. This undulating soil is well drained. It is in plane to slightly convex positions on ground moraines. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is dark grayish brown fine sandy loam about 9 inches thick. The subsurface layer is grayish brown fine sandy loam about 6 inches thick. The subsoil, about 35 inches thick, is dark yellowish brown sandy loam in the upper part and grades to yellowish brown loam and clay loam in the lower part. The underlying material is yellowish brown and olive brown mottled loam. In some areas the surface layer is coarser than fine sandy loam. Slope in some places is less than 2 percent or more than 6 percent.

Included with this soil in mapping are small areas of Bluffton, Nessel, and Rifle soils. The Bluffton and Rifle soils are very poorly drained and occupy depressional areas. Rifle soils also formed entirely in organic soil material, whereas the Hayden soil formed in loamy glacial till. The Nessel soils are moderately well drained and occupy slightly concave positions downslope from Hayden soils.

This Hayden soil has moderate permeability. Surface runoff is slow. The available water capacity is high. Natural fertility is medium, and the organic matter content is low.

Most areas of this soil are used for farming. This soil has good potential for crops, pasture, and woodland. It has fair potential for sanitary facilities and good potential as building sites.

This soil is well suited to all farm crops commonly grown in the survey area. It warms up fairly early in spring and can be worked fairly soon after rain. The surface may seal after heavy rains and crust upon drying. This soil is easily eroded by water. Erosion can be reduced by incorporating plant residue in the soil or by minimum tillage. Fall plowing permits the soil clods to freeze and thaw in winter and produces a spring seedbed of improved tilth.

This soil is well suited to pasture and hay. Overgrazing or grazing when the soil is too wet, however, will cause soil compaction and increase surface runoff. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. Seedling mortality, equipment limitations, and the hazard of erosion are slight. Plant competition is severe. Tree seedlings and cuttings survive and grow well if competing vegetation is controlled. This can be accomplished by site preparation or by spraying, cutting, or girdling.

This soil is well suited as building sites and for most sanitary facilities. Potential frost heave is moderate in this soil, also moderate changes in volume occur with changes in soil moisture. Soil strength is low. Roads and driveways should be constructed on more suitable base materials to prevent breakup. This soil has fair suitability for septic tank absorption field systems. It is generally easy to establish trees, shrubs, and sod on this soil, although in some places lawns started from seed are hard to establish because of poor soil tilth.

This soil is in capability subclass IIe and woodland suitability group 2o.

132C—Hayden fine sandy loam, 6 to 12 percent slopes. This gently rolling soil is well drained. It is on crests and sides of ground moraines. Delineations are commonly irregular in shape and range from 3 to 15 acres.

Typically, the surface layer is very dark grayish brown fine sandy loam about 4 inches thick. The subsurface layer is dark brown loam about 8 inches thick. The subsoil, about 30 inches thick, is dark yellowish brown loam. The underlying material is olive brown loam. In some areas the surface layer is coarser than fine sandy loam or the underlying material has a reddish color. In a few areas most of the original surface layer has been removed by erosion and the present surface layer is dark yellowish brown loam. In other areas slope is less than 6 percent or more than 12 percent.

Included with this soil in mapping are small areas of Braham, Nessel, Bluffton, and Rifle soils. The Braham soils are well drained and have a sandy surface mantle. The Nessel soils are moderately well drained and occupy slightly concave positions downslope from Hayden soils. The Bluffton and Rifle soils are very poorly drained and occupy depressional areas. Rifle soils formed entirely in organic material, whereas the Hayden soil formed in loamy glacial till.

The Hayden soil has moderate permeability. Surface runoff is medium to rapid. The available water capacity is high. The organic matter content is low, and natural fertility is medium.

Most areas of this soil are farmed. It has good potential for crops, legume and grass hay or pasture, and for trees. It has fair potential for sanitary facilities and good potential as building sites.

Most areas of this soil are cropped to corn, soybeans, or hay. The surface layer tends to seal during rains and to crust upon drying. The main management concerns

are controlling erosion, maintaining tilth and fertility, and improving the water intake of the soil. Slopes are generally too short or too irregular for contour stripcropping or terraces. Minimum tillage that leaves crop residue on the surface and a rotation of grasses and legumes help to control erosion, maintain tilth and fertility, and conserve moisture. Fall plowing allows soil clods to freeze and thaw, producing an early spring seedbed of improved tilth.

This soil is well suited to pasture and hay crops. Overgrazing or grazing when the soil is too wet, however, will cause surface compaction and increase surface runoff. Proper stocking, pasture rotation, and timely deferment of grazing improve forage production by helping to maintain a cover of desirable plants.

This soil is well suited to trees. Seedling mortality, equipment limitations, and the hazard of erosion are slight. There is a hazard of extensive erosion if the soil surface is left bare. Plant competition is severe. Clearing, spraying, or other site preparation is needed before planting to reduce plant competition.

This soil is well suited as building sites and for most sanitary facilities. Potential frost heave is moderate, and moderate changes in volume occur with changes in soil moisture in the upper 2 to 3 feet of this soil. Roads and driveways should be constructed on more suitable base material to prevent breakup. Soil strength is low. Because seepage occurs on side slopes during unusually wet years, drainage tile should be placed around foundation footings to intercept water that may seep into basements.

This soil has only fair suitability for septic tank absorption fields. In places, slope is a limitation and needs to be considered in determining the location of an absorption system. It is generally easy to establish trees, shrubs, and sod on this soil.

This soil is in capability subclass IIIe and woodland suitability group 2o.

132D—Hayden fine sandy loam, 12 to 25 percent slopes. This hilly to steep soil is well drained. It is on short, narrow side slopes of glacial moraines. Individual areas are commonly elongated in shape and range from 3 to 30 acres.

Typically, the surface layer is dark brown fine sandy loam about 6 inches thick. The subsoil is yellowish brown loam about 30 inches thick. The underlying material is dark yellowish brown loam. In some areas the surface layer is coarser than fine sandy loam or is yellowish brown loam. Slope in some places is less than 12 percent or more than 25 percent.

Included with this soil in mapping are small areas of Dundas, Bluffton, and Rifle soils. The Dundas soils are poorly drained and occupy low positions on the landscape. The Bluffton and Rifle soils are very poorly drained and occur in depressional areas. The Rifle soils formed in organic soil material, but the Hayden soil formed in loamy glacial till.

The Hayden soil has moderate permeability. Surface runoff is rapid or very rapid. The available water capacity is high. The organic matter content is low, and natural fertility is medium.

Most areas of this soil are used for permanent pasture or woodland. This soil has poor potential for cultivated crops and fair potential for pasture, hay, and woodland. It has poor potential for sanitary facilities and fair potential as building sites.

This soil is poorly suited to cultivated crops because of steep slopes. There is a severe hazard of erosion if it is farmed. If fertilized and well managed, it provides good pasture. Good management includes proper stocking, rotation grazing, and weed control. Grazing must be controlled to maintain a good cover of the more productive plants. Overgrazing can result in severe erosion. Pastures are difficult to renovate and improve because of the steep slopes.

This soil has fair suitability for trees. Many areas remain in native hardwoods. Plant competition is moderate to severe, and such site preparation as cultivation, spraying, girdling, or clearing is desirable. Furrow planting or planting in existing vegetation reduces erosion and runoff. A protective cover of vegetation should be kept on this soil at all times.

This soil is suited to building site development although steep slope is a severe limitation. Subdivisions can be designed to preserve the natural landscape while reducing grading requirements, erosion, and sedimentation. Erosion should be controlled both during and immediately following construction.

This soil is poorly suited to septic tank absorption fields and other sanitary facilities. In the steeper areas there is a hazard of sidehill seepage of effluent. Lawns, trees, and shrubs are generally easy to establish on this soil. Topdressing of eroded soils is desirable before establishing lawns. It is also a good practice to use sod rather than lawn seed to prevent excessive erosion of bare soil.

This soil is in capability subclass VIe and woodland suitability group 2r.

151—Burkhardt sandy loam, 0 to 3 percent slopes. This level to gently sloping soil is somewhat excessively drained. It is on outwash plains and terraces along major rivers. Individual areas are irregular in shape and range from 20 to 80 acres.

Typically, the surface soil is black and very dark gray sandy loam about 16 inches thick. The subsoil is dark brown gravelly loamy coarse sand about 7 inches thick. The underlying material is brown gravelly coarse sand. In some small areas slope is more than 3 percent.

Included in mapping are small areas of Dickman, Hubbard, and Sparta soils. The Burkhardt soil formed in loamy and sandy deposits, but the somewhat excessively drained Dickman and excessively drained Sparta soils formed in fine and medium sands and lack coarse fragments. The excessively drained Hubbard soils have less gravel in the lower layers than the Burkhardt soil.

Permeability of the Burkhardt soil is moderately rapid in the surface layer and rapid in the subsoil and underlying material. Surface runoff is slow. The available water capacity is low. Natural fertility is medium. The organic matter content is moderate.

Most of this soil is used for crops. This soil has fair potential for crops, pasture, or hay. It has good potential as building sites and poor potential for most sanitary facilities.

This soil has fair suitability for all farm crops commonly grown in the survey area. The main limitation is the low available water capacity. Early-maturing crops are well adapted to this soil because they take advantage of early season moisture. Minimum tillage practices and return of crop residue help maintain tilth, increase available water capacity, and increase fertility. Crops grown on this soil respond well to irrigation.

This soil has fair suitability for permanent pasture or hay, although plant growth is limited by the low available water capacity. It provides good pasture in spring and fall and fair to poor pasture in summer. Proper stocking, pasture rotation, weed control, and timely deferment of grazing help to keep pasture and soil in good condition. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited as building sites. Sidewalls in the sandy underlying material have poor stability and may cave in. This problem can be overcome by enlarging the excavation or by installing temporary retaining walls.

Septic tank absorption fields function well in this soil, but unless they are specially designed, the pollution of ground water is a hazard. Lawns, trees, and shrubs are generally easy to establish; however, additions of water and fertilizer are needed to keep them growing vigorously. This soil is generally a good source of sand. A fair amount of gravel can be screened from the underlying material.

This soil is in capability subclass IIIs. It is not placed in a woodland suitability group.

151B—Burkhardt sandy loam, 3 to 9 percent slopes. This gently sloping to moderately sloping soil is somewhat excessively drained. It is on outwash plains and terraces along major rivers. Individual areas range from 20 to 60 acres and are irregular in shape.

Typically, the surface soil is very dark gray and very dark grayish brown sandy loam about 12 inches thick. The subsoil is dark brown loamy coarse sand and gravelly sandy loam about 11 inches thick. The underlying material is dark yellowish brown stratified coarse sand and gravel. In some small areas slope is less than 3 percent or more than 9 percent.

Included with Burkhardt soil in mapping are small areas of Dickman, Hubbard, and Sparta soils. The Burkhardt soil formed in loamy and sandy deposits; the somewhat excessively drained Dickman and excessively drained Sparta soils formed in fine and medium sand and lack coarse fragments. The excessively drained Hubbard soils have a loamy sand surface layer and contain less gravel than the Burkhardt soil.

Permeability of the Burkhardt soil is moderately rapid in the surface layer and rapid in the underlying material. Runoff is medium. The available water capacity is low. Natural fertility is medium. The organic matter content is moderate.

Most areas of this soil are used for crops. This soil has fair potential for crops and for grass and legume hay and pasture. It has good potential as building sites and poor potential for most sanitary facilities.

This soil has fair suitability for all crops commonly grown in the county. Because of its low available water capacity, early-maturing small grains take better advantage of early season moisture than do the corn and soybeans. Erosion can be controlled by keeping the soil covered with vegetation or crop residue. This can be accomplished by minimum tillage or a rotation containing forage crops. Crops respond well to irrigation.

This soil has fair suitability for permanent pasture and hay, but plant growth is limited by the low available water capacity. It provides good pasture in spring and fall, but production is limited during the drier summer months. Proper stocking, rotation grazing, and weed control help to keep the pasture and soil in good condition. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited as building sites. Sidewalls in the underlying material have poor stability and may cave in. This problem can be overcome by over-excavation or by installing temporary retaining walls.

Septic tank absorption fields function well in this soil, but unless they are specially designed, the pollution of ground water is a hazard. Lawns, trees, and shrubs are generally easy to establish; however, additions of water and fertilizer are needed to keep them growing vigorously. This soil is generally a good source of sand. A fair amount of gravel can be screened from the underlying material.

This soil is in capability subclass IIIe. It is not placed in a woodland suitability group.

153B—Santiago silt loam, 2 to 6 percent slopes. This undulating soil is well drained. It is in plane to slightly convex positions on broad flats and low knolls intermingled with depressions on till plains. Mapped areas are commonly 10 to 100 acres and are irregular in shape.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark brown silt loam about 3 inches thick. The subsoil is about 35 inches thick. The upper part is dark yellowish brown and dark brown silt loam. The lower part is reddish brown and dark reddish brown sandy loam. The underlying material is dark reddish brown sandy loam. In some places the silty mantle is more than 30 inches thick.

Included with this soil in mapping are small areas of moderately well drained Freeon soils and well drained Kingsley soils. The Kingsley soils formed entirely in sandy loam till, whereas the Santiago soil formed in loess and the underlying loamy till. Also included are somewhat poorly drained Freer and poorly drained Auburndale soils which occupy small depressions.

Permeability of the Santiago soil is moderately slow. Surface runoff is slow. The available water capacity is high. Natural fertility is medium, and the organic matter content is moderate.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for most sanitary facilities and good potential for building site development.

Most areas of this soil are used to grow corn and soybeans. It is well suited to crops. The surface layer tends to seal during rains, however, and to crust upon drying. Erosion is a moderate hazard on the steeper slopes, however slopes are generally too short or too irregular to permit effective contour farming or terracing. Minimum tillage, returning crop residue to the soil, and a crop rotation that includes forage crops help to control erosion and maintain the tilth of this soil. Fall plowing permits freezing and thawing of clods during the winter and generally helps to provide a well prepared seedbed early in spring.

This soil is well suited to pasture and hay production. Proper grazing management and weed control will result in an adequate cover of the more productive plants. Interseeding with more desirable and approved species will help to improve yield potential.

This soil is well suited to building site development. Soil strength is low in the silty mantle but is high in the underlying material. Unless properly designed, roads, driveways, and parking lots may be damaged by frost action. The soil has poor trafficability when wet. It has fair suitability for septic tank absorption fields because of the moderately slow permeability. Enlarging the filter field of septic tanks will help the systems function properly. Lawns, trees, and shrubs are generally easy to establish on this soil.

This soil is in capability subclass IIe and woodland suitability group 2o.

153C—Santiago silt loam, 6 to 15 percent slopes. This gently rolling to hilly soil is well drained. It is on crests and sides of hills on ground moraines. Mapped areas are irregular in shape and are commonly 10 to 30 acres.

Typically, the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsurface layer is brown silt loam about 4 inches thick. The subsoil is about 30 inches thick. The upper part is brown and dark brown silt loam. The lower part is reddish brown fine sandy loam. The underlying material is reddish brown sandy loam. In some places the surface layer has eroded and the silty mantle is less than 15 inches thick. In other places the silty mantle is more than 30 inches thick. Slope is less than 6 percent in some mapped areas.

Included with this soil in mapping are small areas of moderately well drained Freeon soils and well drained Kingsley soils. The Kingsley soils formed entirely in sandy loam till, whereas the Santiago soil formed in loess and loamy till. Also included are somewhat poorly drained Freer soils and poorly drained Auburndale soils in small depressions.

Permeability of the Santiago soil is moderately slow. Surface runoff is medium to rapid. The available water capacity is high. Natural fertility is medium, and the organic matter content is moderate.

Most areas of this soil are farmed. It has good potential for crops and for grass and legume hay and pasture. It has good potential for woodland. This soil has fair potential for most sanitary facilities and good potential for building site development.

This soil is well suited to all crops commonly grown in the survey area. Most areas are used to grow corn and soybeans. The surface layer of this soil is easily eroded and tends to seal during rains and crust on drying. Erosion is a severe hazard. In some places contour stripcropping can be used to control erosion, but most slopes are too short or too irregular for effective contour farming. Minimum tillage can control erosion in most places, or a rotation can be used that includes forage crops. Fall plowing permits clods to be broken by freezing and thawing during the winter, which improves tilth.

The use of this soil for pasture and hay is an effective means of controlling erosion. Proper stocking, rotation grazing, and weed control help to keep the pasture and soil in good condition. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to trees. Seedling mortality, equipment limitations, and the hazard of erosion are slight. Clearing, spraying, or other site preparation is needed to eliminate brush and reduce plant competition.

This soil is well suited to building site development although slope is a limitation. Soil strength is low in the silty mantle but it is high in the underlying material. Because sidehill seepage occurs where slope is more than 12 percent, tile should be installed around foundations to drain off accumulated water.

This soil has fair suitability for septic tank absorption fields because of its moderately slow permeability and the hazard of side slope seepage. Lawns, trees, and shrubs are generally easy to establish.

This soil is in capability subclass IIIe and woodland suitability group 2o.

155B—Chetek sandy loam, 0 to 6 percent slopes. This nearly level to undulating soil is somewhat excessively drained. It is on low hills and knolls on broad outwash plains. Delineations are commonly irregular in shape and range from 5 to 20 acres.

Typically, the surface layer is dark grayish brown sandy loam about 8 inches thick, and the subsurface

layer is brown loam about 6 inches thick. The subsoil is about 8 inches thick. The upper part is dark reddish brown gravelly sandy loam, and the lower part is brown gravelly coarse sand. The underlying material is brown and light brown gravelly sand and gravelly coarse sand. In some places the underlying material contains less than 15 percent coarse fragments. In places the sandy loam mantle is thicker than 20 inches. In other areas the slope is more than 6 percent.

Included with this soil in mapping are small areas of Kingsley and Poskin soils. The Kingsley soils are well drained and formed entirely in loamy glacial till, whereas the Chetek soil formed in a loamy mantle and sandy outwash. The Poskin soils are somewhat poorly drained and have a thick silty surface mantle underlain by gravelly sand. They occupy depressions.

The Chetek soil has moderately rapid permeability in the sandy loam mantle and rapid permeability in the gravelly sand underlying material. Surface runoff is slow. Natural fertility, available water capacity, and organic matter content are low.

Most areas of this soil are woodland or cropland. It has fair to poor potential for cultivated crops, pasture, and hay. It has fair potential for woodland. This soil has poor potential for most sanitary facilities and good potential as building sites.

The Chetek soil has fair to poor suitability for crops. The main limitations are low available water capacity and the hazard of erosion. Minimum tillage, crop rotations that include forage crops, and returning crop residues to the soil reduce erosion and improve available water capacity and fertility. This soil is well suited to irrigation.

The production of hay crops is limited by low available water capacity. Conservation practices for hayland include planting approved and adapted species, fertilizing, and timely harvesting. When the soil is pastured, proper stocking, rotation grazing, and weed control help to maintain an adequate vegetative cover. Supplemental pasture is usually needed during the dry summer months.

This soil has fair suitability for trees. Tree seedlings survive and grow well if competing vegetation is controlled. Site preparation, spraying, or clearing are desirable methods of controlling competing vegetation.

This soil is well suited to building site development and is poorly suited to most sanitary facilities. Sidewalls of the underlying sand and gravel have poor stability and may cave in during excavation. This can be prevented with temporary retaining walls.

Septic tank absorption fields function well in this soil. Because of the rapidly permeable underlying material, however, they must be specially designed to prevent the pollution of ground water supplies. Revegetating the landscape may be difficult, and additions of water and fertilizer are needed to keep lawns, trees, and shrubs growing vigorously. A loamy topdressing may be desirable before establishing lawns. This soil is generally a good source of sand for construction. Consideration should be given to this resource before developing the soil for other uses.

This soil is in capability subclass IIIe and woodland suitability group 3s.

155C—Chetek sandy loam, 6 to 12 percent slopes. This gently rolling soil is somewhat excessively drained. It is on crests and sides of hills on pitted outwash plains. Delineations are irregular in shape and range from 5 to 20 acres.

Typically, the surface layer is brown sandy loam about 6 inches thick. The subsoil is reddish brown sandy loam about 12 inches thick. The underlying material is strong brown gravelly sand. In some places the underlying material contains less than 15 percent coarse fragments. In places the loamy mantle is thicker than 20 inches or thinner than 12 inches. In other places the slope is less than 6 percent or more than 12 percent.

Included with this soil in mapping are small areas of Kingsley and Poskin soils. The Kingsley soils are well drained and formed entirely in loamy glacial till, whereas the Chetek soil formed in a loamy mantle and sandy outwash. The Poskin soils are somewhat poorly drained and have a thick silty surface mantle underlain by gravelly sand. They occupy depressions.

The Chetek soil has moderately rapid permeability in the sandy loam mantle and rapid permeability in the gravelly sand underlying material. Surface runoff is medium. Natural fertility, available water capacity, and organic matter content are low.

Most of this soil is woodland and cropland. It has poor potential for crops and fair potential for pasture and hay. It has fair potential for woodland. This soil has poor potential for most sanitary facilities and good potential as building sites.

This soil is poorly suited to crops because of its low available water capacity and susceptibility to erosion. The main management needs are controlling erosion, increasing fertility, and improving tilth. Returning crop residue to the soil improves available water capacity, fertility, and soil tilth. Slopes are generally too short for stripcropping or contouring. Minimum tillage can be used to reduce soil erosion and runoff. This soil is suited to irrigation if an adequate water supply is available.

This soil has fair suitability for pasture and hay if properly managed. When it is used for pasture, proper stocking, rotation grazing, and weed control are needed to maintain good cover. Because of the low available water capacity, supplemental pastures usually are required during the drier summer months. It is important to prevent overgrazing of pastures, because this soil erodes easily when overgrazed.

This soil has fair suitability for trees. Seedling mortality is dependent on available water and can be expected to be high if a dry season follows planting. Competition from undesired species generally does not kill or restrict the growth of seedlings. The use of harvesting or planting equipment is not restricted by time of year or type of

equipment. Erosion is a problem on this soil. Diversions or grassed waterways may be needed to divert water from higher slopes and prevent erosion.

This soil is well suited to building site development although slope is a moderate limitation. It is poorly suited to sanitary facilities due to slope and the rapid permeability in the underlying material. If buildings are designed to fit the site, the natural landscape can be preserved, less grading is required, and erosion and sedimentation are reduced. Erosion control may be needed, both during and immediately following construction. Sidewalls have poor stability and may cave in during excavation. This can be prevented with temporary retaining walls.

Septic tank absorption fields function well in this soil because of the rapidly permeable underlying material, however, they must be specially designed to prevent pollution of ground water supplies. Revegetation of disturbed areas is difficult. Additions of water and fertilizer are usually needed to keep lawns, trees, and shrubs growing vigorously. This soil is a good source of sand for construction.

This soil is in capability subclass IVe and woodland suitability group 3s.

155D—Chetek sandy loam, 12 to 25 percent slopes. This hilly to steep soil is somewhat excessively drained. It is on crests and sides of hills on pitted outwash plains. Delineations are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is dark grayish brown sandy loam about 6 inches thick. The subsoil is dark yellowish brown sandy loam about 8 inches thick. The underlying material is reddish brown sand and gravel. In some places the underlying material contains less than 15 percent coarse fragments. In places the sandy loam mantle is more than 20 or less than 12 inches thick. In other areas the slope is less than 12 percent or more than 25 percent.

Included with this soil in mapping are small areas of Kingsley and Poskin soils. The Kingsley soils are well drained. They formed entirely in loamy glacial till, whereas the Chetek soil formed in a loamy mantle over sandy outwash. The Poskin soils are somewhat poorly drained and have a thick silty surface mantle underlain by gravelly sand. They occupy depressions.

The Chetek soil has moderately rapid permeability in the sandy loam mantle and rapid permeability in the gravelly sand underlying material. Surface runoff is rapid to very rapid. Natural fertility, available water capacity, and organic matter content are low.

Most areas of this soil are woodland or permanent pasture. Some isolated areas are cropland. This soil has poor potential for crops and fair to poor potential for pasture. It has fair potential for woodland. It has poor potential for sanitary facilities and fair potential as building sites.

This soil generally is not suited to crops because of steep slopes, the severe hazard of erosion, and low available water capacity. It is too shallow to sand and gravel and slopes generally are too short and steep for stripcropping or contouring.

The use of the soil for pasture or hay is effective in controlling erosion, but yields are low due to the low available water capacity. Proper stocking will prevent weeds and the less desirable plant species from invading the pastures. Rotation grazing, fertilization, and weed control are also good management practices. Overgrazed pastures can be helped by reseeding with more productive plant species. This soil erodes easily if overgrazed.

This soil has fair suitability for trees. The hazard of erosion is severe. Furrow planting on the contour or planting in existing vegetation reduces erosion and helps to conserve moisture. Grassed waterways and diversions also help prevent erosion.

This soil is suited to building site development, although slope is a severe limitation. It is poorly suited to most sanitary facilities. Erosion needs to be controlled both during and immediately following construction. If buildings are designed to fit the site, the natural landscape can be preserved, less grading is required, and erosion and sedimentation are reduced. Sidewalls of the underlying material have poor stability and may cave in. This can be prevented with temporary retaining walls.

This soil is poorly suited to septic tank absorption fields because of steep slopes and rapid permeability, which may cause the pollution of ground water. Lawns and gardens need repeated watering and fertilizing to grow vigorously. A loamy topdressing may be desirable before establishing lawns. This soil is a good source of sand for construction. Consideration should be given to this resource before developing the soil for other uses.

This soil is in capability subclass VIe and woodland suitability group 3f.

158B—Zimmerman loamy fine sand, 0 to 6 percent slopes. This level to gently sloping soil is excessively drained. It occupies convex knolls and side slopes on outwash plains and lake plains. Individual areas are irregular in shape and range from 5 to 60 acres.

Typically, the surface layer is dark grayish brown loamy fine sand about 9 inches thick. The subsurface layer is grayish brown loamy fine sand about 6 inches thick. The underlying layers are stratified light yellowish brown to dark brown fine sand and thin, discontinuous bands of dark brown loamy fine sand 1/4 to 1 inch thick. Above a depth of 60 inches these bands typically have an aggregate thickness of less than 6 inches. In some delineations these bands have a thickness of more than 6 inches or there are no bands. Strata of medium and coarse sands are in some small areas. In other areas slope is more than 6 percent.

Included with this soil in mapping are small areas of moderately well drained Lino Variant soils in lower positions on the landscape. Somewhat poorly drained Lino soils and very poorly drained Isanti soils occur in depressions and drainageways.

This Zimmerman soil has rapid permeability. Surface runoff is very slow to slow. The available water capacity is low. Natural fertility is low, and organic matter content is low.

Most areas of this soil are farmed. Many areas are developed for urban uses. This soil has poor potential for all the common crops grown in the survey area. It has fair potential for pasture and woodland. This soil has poor potential for most sanitary facilities and good potential as building sites.

This soil is poorly suited to agricultural crops because of its low available water capacity and low natural fertility. Early-maturing crops, such as small grains, usually make best use of the early spring soil moisture. Minimum tillage, returning crop residue to the soil, and forage crops in the rotation increase the organic matter content and water holding capacity of the soil. A fertilization program is needed to offset the low natural fertility. This soil is suitable for irrigation if a water source is available, although the rapid intake and low retention of water are disadvantages.

Production of pasture is fair in the spring and fall but low during the summer months. If this soil is used for pasture or hay, good grazing management and weed control are needed to maintain the vegetative cover. It is important to prevent overgrazing because this soil erodes easily when overgrazed. Where planting is necessary to improve stands, more drought resistant species are desirable. Rotation grazing and fertilization can also be used.

This soil has fair suitability for woodland. Seedling mortality is only moderate, but if a good rainfall follows planting, seedling survival generally is good. Plant competition and equipment limitations are slight. The hazard of soil blowing is severe. Mulch or a protective sod cover is necessary to protect young seedlings from damage.

This soil is well suited to building site development. It is poorly suited to most sanitary facilities due to its rapid permeability. Soil strength for foundations is good. Excavation is relatively easy, but sidewalls have poor stability and may cave in during excavation or installation of underground utilities. This can be prevented with temporary retaining walls.

Septic tank absorption fields function well in this soil, but unless they are specially designed, there is a hazard of pollution of underground water supplies and nearby lakes and streams. Lawns, trees, and shrubs are difficult to establish on this soil and require frequent watering and fertilization.

This soil is in capability subclass IVs and woodland suitability group 3s.

158C—Zimmerman loamy fine sand, 6 to 12 percent slopes. This moderately sloping soil is excessively drained. It occupies convex knolls and side slopes on outwash plains and lake plains. Individual areas are irregular in shape and range from 3 to 20 acres.

Typically, the surface layer is dark brown loamy fine sand about 8 inches thick. The subsurface layer is grayish brown loamy fine sand about 4 inches thick. The subsoil is stratified light gray to pale brown fine sand that has thin, discontinuous, dark brown loamy fine sand bands 1/4 to 1 inch thick. Above a depth of 60 inches, these bands generally have an aggregate thickness of less than 6 inches. In small areas they have a thickness of more than 6 inches or there are no bands. Some small areas have strata of sand, coarse sand, and loamy coarse sand. In some areas slope is less than 6 percent or more than 12 percent.

Included with this soil in mapping are small areas of moderately well drained Lino Variant soils in lower, less sloping positions on the landscape. Also included are areas of somewhat poorly drained Lino soils and very poorly drained Isanti soils in depressions and small drainageways.

This Zimmerman soil has rapid permeability. Surface runoff is medium. The available water capacity is low. Natural fertility is low, and organic matter content is low.

Most areas of this soil are used for crops and pasture. This soil has poor potential for crops and fair potential for woodland and pasture. It has poor potential for most sanitary facilities and good potential as building sites.

This soil is generally not suited to crops because of its low available water capacity and low natural fertility and the severe erosion hazard. Early-maturing crops, such as small grains, usually make best use of the early spring moisture. Fertilization is needed to offset the low natural fertility. This soil is suitable for irrigation if a water source is available, although the rapid intake and low retention of water are disadvantages. Farming on the contour and leaving crop residue on the surface help to reduce erosion. Green manure crops increase the available water capacity and the fertility of the soil.

Production of pasture is fair in the spring and fall but is very low during the summer months. It is important to prevent overgrazing because this soil erodes easily if not adequately covered with vegetation. Overgrazing also causes less productive plant species and weeds to invade the pastures. Fertilization is needed to overcome the low natural fertility of this soil.

This soil has fair suitability for trees. Seedling mortality is moderate due to droughtiness and wind damage. Seedling survival generally is good if rainfall follows planting. Mulching or a protective sod covering reduces the damage to young seedlings by soil blowing. Plant competition and equipment limitation are slight.

This soil is well suited to building site development although slope is a moderate limitation. It is poorly suited to most sanitary facilities. Because this soil is noncohesive, gullies can easily develop from the increased runoff from roofs and streets. Erosion needs to be controlled during construction. Foundations are relatively easy to excavate, but sidewalls have poor stability and may cave in during excavation or installation of underground utilities. This can be prevented with temporary retaining walls.

Septic tank absorption fields function well in this soil, but unless they are specially designed, the pollution of

underground water supplies and nearby lakes and streams is a hazard. Filter fields become more difficult to lay out as the slope steepens. Lawns, trees, and shrubs are difficult to establish on this soil and require frequent watering and fertilization.

This soil is in capability subclass VIs and woodland suitability group 3s.

158D—Zimmerman loamy fine sand, 12 to 25 percent slopes. This moderately steep to steep soil is excessively drained. It occupies narrow, convex ridgetops and short side slopes adjacent to drainageways and depressions on lake plains and outwash plains. Individual areas are irregular in shape and range from 3 to 30 acres.

Typically, the surface layer is grayish brown loamy fine sand about 8 inches thick. The subsurface layer is grayish brown loamy fine sand about 6 inches thick. The subsoil is stratified light gray to pale brown fine sand that has thin, discontinuous bands of dark brown loamy fine sand 1/4 to 1 inch thick. Above a depth of 60 inches these bands typically have an aggregate thickness of less than 6 inches. In some delineations, however, they have an aggregate thickness of more than 6 inches or there are no bands. In some areas the underlying material is sand or coarse sand. In some small areas slope is less than 12 percent.

Included with this soil in mapping are small areas of Braham and Demontreville soils. They formed in a moderately deep sandy mantle over glacial till, whereas the Zimmerman soil formed in fine sandy material. Steep slopes that have been reworked by man are included in some delineations.

The Zimmerman soil has rapid permeability. Surface runoff is rapid and very rapid. The available water capacity, natural fertility, and organic matter content are low.

Most areas of this soil are used for permanent pasture or woodland. This soil has fair potential for pasture and for woodland. It has poor potential for sanitary facilities and as building sites.

This soil is best suited to pasture and hay crops. It is generally not suited to crops due to its low available water capacity and low natural fertility and the severe hazard of erosion on the steep slopes. It provides fair pasture in the spring and fall, but production is very low during the hot summer months. Proper stocking, fertilization, rotation, and weed control help to maintain the more desirable plants in the pasture. It is important to prevent overgrazing because this soil erodes easily when not adequately covered with vegetation.

This soil has fair suitability for woodland. Seedling mortality and erosion hazard are moderate. Seedling survival of planted stock is good if furrowing and scalping are used in preparing the seedbed and favorable moisture conditions follow planting. Furrow planting or planting in existing vegetation will reduce erosion and conserve moisture by reducing runoff. Plant competition is slight, and equipment limitations are moderate.

This soil is suited to building site development although steep slopes increase the difficulty of preparing the site. Sidewalls have poor stability and may cave in during excavation or installation of underground utilities. This can be prevented with temporary retaining walls. Erosion needs to be controlled during construction. Increased runoff from roads and streets can cause severe erosion. Retaining walls and land shaping in many places help to make desirable homesites.

This soil is poorly suited to sanitary facilities. Downslope seepage of effluent from septic tanks is a severe hazard, and there is a possibility of pollution of underground water supplies and nearby lakes and streams. Vegetation is difficult to establish and maintain on this soil because of steepness of slope and droughtiness. If established, it requires frequent watering and fertilization.

This soil is in capability subclass VIs and woodland suitability group 4s.

159—Anoka loamy fine sand, 0 to 3 percent slopes. This level to very gently sloping soil is well drained. It is on low knolls and flats intermingled with depressions. Individual areas are irregular in shape and range from 5 to 100 acres.

Typically, the surface layer is very dark grayish brown loamy fine sand about 9 inches thick. The subsurface layer is grayish brown loamy fine sand about 11 inches thick. The subsoil is about 40 inches thick and consists of alternating layers of dark brown and brown fine sand and loamy fine sand. Above a depth of 60 inches, these bands of loamy fine sand typically have an aggregate thickness of at least 6 inches. In some places the aggregate thickness is less than 6 inches. Small areas where slope is more than 3 percent are in some delineations.

Included with this soil in mapping are small areas of Soderville and Lino soils which are somewhat poorly drained, are less sloping and lower on the landscape than the Anoka soil, and have a higher water table. Areas of very poorly drained Isanti soils are in depressions. Also included are small areas of a soil that has strata of medium and coarse sand.

Permeability of the Anoka soil is moderately rapid. Surface runoff is very slow to slow. The available water capacity is moderate. Natural fertility is low, and organic matter content is low.

Most areas of this soil are farmed. This soil has fair potential for crops, pasture, and hay. It has fair potential for woodland. It has poor potential for most sanitary facilities and good potential as building sites.

This soil has fair suitability for row crops, small grains, and grass and legume hay or pasture. Droughtiness and soil blowing are the major concerns of management. Management that increases organic matter content will increase the water holding capacity of the soil. Minimum tillage, no-till planting, and cover crops help to maintain organic matter content, reduce soil blowing, and conserve moisture. Crops with low moisture requirements, such as small grains, make best use of the early spring

soil moisture. Fertilization is needed to offset the low natural fertility. This soil is suitable for irrigation if a water source is available, although the rapid intake and low retention of water is a disadvantage.

This soil has only fair suitability for pasture and hay because of the lack of water and nutrients for plant growth. When it is used for pasture or hay, proper stocking, rotation grazing, fertilization, and weed control are needed to maintain a good vegetative cover. It is important to prevent overgrazing because this soil erodes easily when overgrazed. Supplemental pastures are usually needed during the drier summer months.

This soil has fair suitability for woodland. Before planting, competing vegetation should be removed by girdling, clearing, or spraying. Because the soil is sandy, the use of some kinds of equipment is limited. Survival of seedlings depends on rainfall and generally is good if a few good rains fall after planting. Furrow planting helps to collect the water needed for the planted trees. Seedlings are subject to damage from soil blowing unless a protective cover of vegetation is kept on this soil. Mulching with straw or hay before planting helps to protect seedlings from wind damage.

This soil is well suited to building site development. Excavation is relatively easy, but sidewalls have poor stability and may cave in during excavation for foundations or installation of underground utilities. This can be prevented with temporary retaining walls.

Septic tank absorption fields function well in this soil, but unless they are specially designed there is a hazard of pollution of underground water supplies and nearby lakes and streams. Lawns, trees, and shrubs are difficult to establish on this soil and require frequent watering and fertilization.

This soil is in capability subclass IIIs and woodland suitability group 3s.

159B—Anoka loamy fine sand, 3 to 9 percent slopes. This gently sloping to moderately sloping soil is well drained. It is on low knolls and ridges. Individual areas are irregular in shape and range from 3 to 40 acres.

Typically, the surface layer is dark grayish brown loamy fine sand about 8 inches thick. The subsurface layer is grayish brown loamy fine sand about 15 inches thick. The subsoil consists of alternating layers of brown and dark brown fine sand and loamy fine sand. Above a depth of 60 inches the bands of loamy fine sand typically have an aggregate thickness of at least 6 inches. In some small areas they have an aggregate thickness of less than 6 inches. In small areas slope is less than 3 percent or more than 9 percent.

Included with this soil in mapping are small areas of Soderville and Lino soils which are somewhat poorly drained and occupy lower, less sloping positions on the landscape than the Anoka soil. Areas of very poorly drained Isanti soils are in depressions. Also included are small areas of a soil that has strata of medium and coarse sands.

Permeability of the Anoka soil is moderately rapid. Surface runoff is slow to medium. The available water capacity is moderate. Natural fertility is low, and organic matter content is low.

Most areas of this soil are farmed. This soil has fair potential for crops, pasture, and hay. It has fair potential for woodland. It has poor potential for most sanitary facilities and good potential as building sites.

Because of the moderate available water capacity and the hazard of erosion, this soil is not well suited to row crops. Management is needed to control water erosion and soil blowing. Minimum tillage, no-till planting, and cover crops help to maintain organic matter content, reduce soil blowing, and conserve moisture. A crop rotation containing forage crops will help to control water erosion. Field windbreaks will help to control wind erosion. Stubble mulch tillage that keeps the surface rough and trashy is desirable. Fertilization is needed to offset the low natural fertility. This soil is suitable for irrigation if a water source is available.

The use of this soil for permanent pasture and hay is an effective means of controlling erosion. This soil produces fair pasture in spring and fall, but because it is droughty, it produces little forage in summer. Supplemental pasture may be necessary. Planting pasture and hay may be desirable to improve plant species and potential yield. Overgrazing must be avoided to prevent erosion and maintain the sod.

This soil has fair suitability for woodland. Competing vegetation should be removed before planting trees. Seedling mortality depends largely on moisture available, and survival generally is good if a few good rains fall after planting. Planting the trees in furrows helps to collect the water needed for the planted trees. This soil is subject to soil blowing, and young seedlings are easily damaged by blowing sand. A protective cover of vegetation or mulching with straw or hay at time of planting will help to protect the seedlings. Use of some kinds of equipment is limited because of the sandy nature of this soil. Work can be done during most of the year, but if logging is done in summer, roots of trees are likely to be damaged.

This soil is well suited to building site development, although the steepness of some slopes is a moderate limitation. Erosion needs to be controlled during construction on these steeper slopes. Excavation is relatively easy, but sidewalls have poor stability and may cave in during excavation for foundations or installation of underground utilities. This can be prevented by using temporary retaining walls.

Septic tank absorption fields function well in this soil, but unless they are specially designed, there is a hazard of pollution to underground water supplies and nearby lakes and streams. Lawns, trees, and shrubs are difficult to establish on this soil and require frequent watering and fertilization.

This soil is in capability subclass IIIe and woodland suitability group 3s.

161—Isanti loamy fine sand. This is a level, very poorly drained soil. It is in depressions and drainageways and on flats on outwash plains, often adjacent to organic soils. Individual areas range from 5 to 80 acres and are irregular in shape.

Typically, the surface soil is black loamy fine sand about 13 inches thick. The subsoil is about 29 inches thick. The upper part is dark gray loamy fine sand. The lower part is grayish brown fine sand. The underlying material is gray loamy fine sand. In some places this soil contains thin layers of coarse sand.

Included with this soil in mapping are small areas of Lino and Markey soils. Lino soils are somewhat poorly drained and occur in the deeper parts of some depressions. Markey soils are very poorly drained. They formed in 16 to 51 inches of organic material over sand.

Permeability of the Isanti soil is rapid. The available water capacity is low. Surface runoff is ponded or very slow. Natural fertility is low, and the organic matter content is high. The seasonal high water table is at or within 2 feet of the surface.

Most areas of this soil are idle or are used for pasture. Some areas are drained and cropped. Unless drained, this soil has poor potential for crops. The potential of this soil for sanitary facilities and as building sites is poor. It is good for wildlife habitat.

This soil is poorly suited to agricultural crops. Because the high water table is the main limitation, internal drainage is needed to make it suitable for most crops. Irrigation and drainage are generally not desirable because of the low available water capacity of this soil. If it is used for pasture and hay, drainage and seeding with approved adapted plant species will improve potential yield.

Because of wetness, this soil is poorly suited to sanitary facilities and as building sites. If it is used for buildings, tile drainage is necessary or the foundation should be placed above the water table. This soil is easy to excavate, but sidewalls have poor stability and may cave in. This can be prevented by using temporary retaining walls or by enlarging the excavation. This soil has moderate susceptibility to frost action. Streets, driveways, and parking lots are subject to cracking unless properly designed.

Septic tanks do not function well in this soil because of the high water table and a hazard of pollution of groundwater supplies and nearby lakes or streams. Some areas are suitable for parks and recreational areas if drained. This soil is well suited to wetland wildlife habitat. Suitable water habitat is relatively easy to develop. The water level is fairly easy to maintain at the desired level. Wetland food and cover plants can be expected to grow well.

This soil is in capability subclass IVw. It is not placed in a woodland suitability group.

162—Lino loamy fine sand. This is a level to very gently sloping, somewhat poorly drained soil. It is in depressions and small waterways and on broad low-lying flats on outwash plains. Individual areas range from 5 to 30 acres and are irregular in shape.

Typically, the surface layer is dark grayish brown loamy fine sand about 9 inches thick. The subsoil is about 27 inches thick. The upper part is pale brown, mottled loamy fine sand. The lower part is light brownish gray, mottled loamy fine sand. The underlying material is light brownish gray, mottled fine sand. In some places the surface layer is sand. In other places the underlying material is medium sand.

Included with this soil in mapping are small areas of Zimmerman and Isanti soils. Zimmerman soils are excessively drained and occur on small convex hills. Isanti soils are very poorly drained and occur in the deeper parts of depressions.

The Lino soil has rapid permeability. Surface runoff is very slow to slow. The available water capacity is low. The natural fertility and the organic matter content are low. A seasonal high water table is commonly 2 to 4 feet below the surface.

Most areas of this soil are used for crops or pasture. Some areas are used for woodland or urban development. This soil has poor potential for crops and fair potential for pasture, hay, and woodland. It has poor potential for sanitary facilities and fair potential as building sites.

Crop growth is limited by wetness unless this soil is drained. Drainage is not needed, however, if adjacent lower lying soils are drained. Good drainage outlets are often lacking. Soil blowing is a hazard on this soil and can be controlled by no-tillage or by maintaining a cover of crop residues. The use of this soil for pasture is limited in summer by the low available water capacity. Overgrazing should be avoided because this soil erodes easily when overgrazed.

This soil has fair suitability for trees. The site must be prepared to control competing vegetation. It should be mulched during planting, and later a protective sod cover should be maintained. Planting trees in furrows reduces soil blowing and helps collect the water needed by the trees. Seedling mortality is moderate to severe. The survival of seedlings depends mainly on timely rainfall, but seedlings are also subject to damage from soil blowing. Tree growth is limited by the low fertility and low available water capacity of this soil.

This soil is suited to building site development if wetness is controlled. If buildings are constructed on this soil, the water table should be lowered or the foundation should be constructed above the water table (fig. 8). Because excavations and trenches are subject to collapsing, temporary retaining walls should be used. This soil has moderate susceptibility to frost action. Streets, driveways, and parking lots are subject to cracking unless properly designed.

This soil is poorly suited to sanitary facilities. Septic tank absorption fields function poorly because of the high water table, and they may pollute the ground water and nearby lakes or streams. Lawns are difficult to establish on this soil.

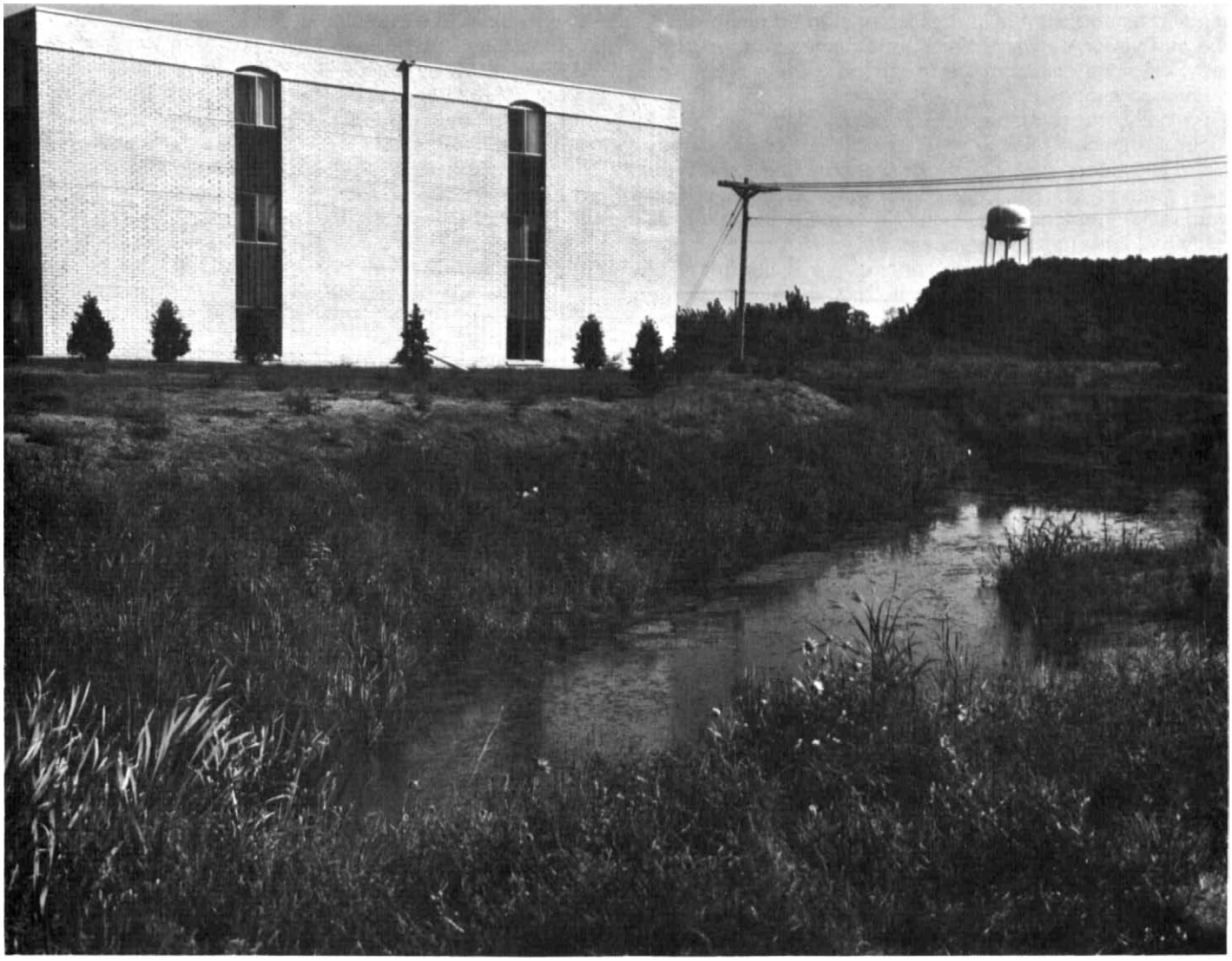

Figure 8.—Foundations are placed above the water table when buildings are constructed on the Lino soils.

This soil is in capability subclass IVw and woodland suitability group 3s.

166—Ronneby fine sandy loam. This is a level, somewhat poorly drained soil. It is in depressions on moraines. Individual areas range from 3 to 20 acres and are irregular in shape.

Typically, the surface layer is very dark grayish brown fine sandy loam about 9 inches thick. The subsurface layer, which is about 9 inches thick, is light brownish gray, mottled fine sandy loam. The subsoil is about 23 inches thick. The upper part is dark grayish brown, mottled loam. The lower part is reddish brown, mottled sandy loam. The underlying material is reddish brown, mottled sandy loam. In places the surface layer is silt loam.

Included with this soil in mapping are small areas of Freer and Prebish soils. Freer soils are somewhat poorly drained and have a silt loam surface layer and subsoil. Prebish soils are very poorly drained and occur in depressions.

This Ronneby soil has moderately rapid permeability in the surface layer and subsoil and moderately slow permeability in the underlying material. Surface runoff is very slow. The available water capacity is moderate. Natural fertility is low, and the organic matter content is moder-

ate. The seasonal high water table is at a depth of 1.5 to 3 feet.

Most areas of this soil are used for crops or pasture, and some areas are in woodland. It has fair potential for crops and woodland and good potential for pasture and hay. It has poor potential for sanitary facilities and fair potential as building sites.

If drained and properly managed, this soil is well suited to corn and soybeans. If this soil is plowed in fall, freezing and thawing in winter breaks the clods and provides a good seedbed in the spring. Stones are often a problem when tilling. Because this soil usually is moist throughout the summer, it is well suited to pasture. Many areas of pasture are wooded or brushy and can be improved by clearing. Grazing should be delayed during wet periods because the sod can be damaged if grazed when too wet.

Ronneby soils have fair suitability for trees. Plant competition is severe and should be controlled. Competing vegetation can be controlled by girdling, spraying, cutting, and mechanical means. Equipment use is limited by wetness in early spring and after heavy rains.

This soil is suitable as building sites if the wetness is controlled. If it is used for building, foundations need to be drained unless fill is used to raise them above the seasonal high water table. This soil is highly susceptible to frost action. Streets, sidewalks, and small buildings can be damaged by frost heave unless carefully designed. Because of the wetness and moderately slow permeability, septic tank absorption fields function poorly in this soil. Lawns, trees, and shrubs are generally easy to establish.

This soil is in capability subclass IIw and woodland suitability group 2d.

169B—Braham loamy fine sand, 1 to 6 percent slopes. This gently undulating to undulating soil is well drained. It is in low areas on ground moraines or till plains. Slopes are convex and concave. Delineations are irregular in shape and range from 10 to 60 acres.

Typically, the surface layer is dark grayish brown loamy fine sand about 9 inches thick. The subsurface layer is yellowish brown loamy fine sand about 19 inches thick. The subsoil is dark yellowish brown sandy clay loam about 11 inches thick. The underlying material is olive brown fine sandy loam and loam. In some areas the underlying material is yellowish brown silt loam. In places the sandy mantle is less than 20 inches thick. In other places slope is more than 6 percent.

Included with this soil in mapping are small areas of Zimmerman, Blomford, Kratka, and Cathro soils. The Zimmerman soils are excessively drained. They formed entirely in sandy glacial outwash, whereas the Braham soil formed in a sandy mantle over loamy glacial till. The Blomford soils are poorly drained and occupy lower, less sloping areas. The Kratka soils are poorly drained and occupy depressions and drainageways. The Cathro soils are very poorly drained. They formed in organic soil material and occupy wet depressions. In some of the lower, less sloping areas the soil has mottles in the lower part of the subsoil.

Braham soils have rapid permeability in the upper sandy layers and moderate permeability in the underlying glacial sediment. Surface runoff is slow. The available water capacity is moderate. Natural fertility and organic matter content are low.

Most areas of this soil are used for crops or pasture. It has fair potential for crops, pasture, and woodland. It has fair potential for sanitary facilities and good potential as building sites.

This soil has fair suitability for most crops commonly grown in the survey area. It is well suited to irrigation. Small grains and forage crops are better suited than later maturing crops, such as corn and soybeans. Low natural fertility, soil blowing, droughtiness, and water erosion are the major concerns of management. In most years plant growth is limited by lack of moisture. Crops respond well to fertilization if rainfall is timely or if irrigation is provided. Lime is needed in most areas. Pasture productivity is fair for all kinds of forage except wetland species.

This soil has fair suitability for trees. Seedling mortality and plant competition are moderate. Soil blowing is a hazard and should be controlled to prevent damage to young seedlings. Equipment limitations are slight.

This soil has fair suitability for sanitary facilities and is well suited to building site development. Special consideration should be given to the sandy mantle when constructing septic tank absorption fields and dwellings. It permits rapid infiltration of water or effluent which then may be temporarily trapped above the loamy underlying material. Tile drains placed around the foundations help to keep water out of basements. Septic tank absorption fields should be designed to function in the loamy underlying material, not the sandy surface mantle. In places, permeability may be sufficiently restricted in the loamy underlying material so that a specially designed absorption system is needed. It is essential that individual sites be carefully investigated. Revegetation of this soil may be difficult because of the sandy mantle. Additional water may be needed to keep plants growing. A loamy topdressing, 12 to 18 inches thick, should be added before establishing lawns.

This soil is in capability subclass IIIs and woodland suitability group 2s.

169C—Braham loamy fine sand, 6 to 15 percent slopes. This gently rolling to hilly soil is well drained. It occupies crests and sides of hills on till plains or ground moraines. Delineations are commonly irregular in shape and range from 5 to 30 acres.

Typically, the surface layer is dark grayish brown loamy fine sand about 6 inches thick. The subsurface layer is yellowish brown loamy fine sand about 17 inches thick. The subsoil is dark yellowish brown sandy clay loam about 9 inches thick. The underlying material is

olive brown fine sandy loam and loam. In some places the sandy mantle is less than 20 inches thick. In some areas the underlying material is yellowish brown silt loam. Also in places slope is less than 6 percent or more than 15 percent.

Included with this soil in mapping are small areas of Zimmerman, Blomford, Kratka, and Cathro soils. The Zimmerman soils are excessively drained. They formed entirely in sandy glacial outwash, whereas the Braham soil formed in a sandy mantle over loamy glacial till. The Blomford soils are poorly drained and occupy low areas. The Kratka soils are poorly drained. They are in depressions and lower drainageways. The Cathro soils are very poorly drained and formed in organic soil material. They occupy wet depressions. Small areas of less sloping soil have mottles in the lower part of the subsoil.

The Braham soil has rapid permeability in the upper sandy layers and moderate permeability in the lower part. Surface runoff is medium to rapid. The available water capacity is moderate. Natural fertility and organic matter content are low.

Most areas of this soil are used for pasture and hay. This soil has poor potential for crops. It has fair potential for pasture, hay, and woodland. It has fair potential for sanitary facilities and good potential as building sites.

This soil is poorly suited to crops. On the lesser slopes, small grains and forage crops can be grown. Slopes of more than 12 percent should have a continuous vegetative cover to control erosion. Low natural fertility, soil blowing, water erosion, droughtiness, and moderately steep slopes are the major limitations for crop production. In most years plant growth is limited by lack of moisture. Returning crop residue to the soil helps improve available water holding capacity and fertility. Lime is needed in most areas. This soil is suited to irrigation if an adequate water supply is available.

Pasture productivity is fair for all kinds of forages except wetland species. Proper stocking, rotation grazing, weed control, and fertilization help to maintain the vegetative cover. It is important to prevent overgrazing because this soil erodes easily when overgrazed. Supplemental pastures are usually needed during the drier summer months.

This soil has fair suitability for trees. Seedlings survive and grow well if competing vegetation is controlled or removed. Site preparation or girdling, spraying, or cutting is an acceptable method of controlling competing vegetation. Seedlings may not survive if a dry year follows planting. On slopes of more than 12 percent, diversions or grassed waterways may be needed to prevent gully erosion.

This soil is well suited to building site development, although slope is a limitation. There is a hazard of side slope seepage on the stronger slopes. Special consideration should be given to the sandy mantle during construction of dwellings. It permits rapid infiltration of water, which may then be trapped temporarily above the loamy underlying material. To guard against water seepage into basements, a tile drainage system may be needed. Individual sites should be investigated carefully.

This soil has fair suitability for sanitary facilities. Septic tank absorption fields should be designed to function in the loamy underlying material rather than in the porous sandy surface mantle. In places, however, the permeability of the underlying material may be sufficiently restricted to require a specially designed absorption system. Onsite investigation is essential. Revegetation of this soil may be difficult, especially in the steeper areas. Sod or mulch may be needed to reduce erosion.

This soil is in capability subclass IVe and woodland suitability group 2s.

170—Blomford loamy fine sand. This is a nearly level, poorly drained soil. It occupies small depressions, drainageways, and flats on glacial till plains. Mapped areas are commonly irregular in shape and range from 5 to 20 acres.

Typically, the surface layer is very dark grayish brown loamy fine sand about 9 inches thick. The subsurface layer is grayish brown, mottled loamy fine sand about 16 inches thick. The subsoil is grayish brown, mottled sandy clay loam about 14 inches thick. The underlying material is olive, mottled loam. In some areas the surface mantle is finer than loamy fine sand. The surface layer has darker colors in places.

Included with this soil in mapping are small areas of Braham, Lino, Markey, and Kratka soils. The Braham soils are well drained and occupy rises and knolls. The Lino soils are somewhat poorly drained. They formed entirely in sandy outwash material, whereas the Blomford soil formed in a sandy mantle over loamy glacial till. The Markey soils are very poorly drained and have a thick surface mantle of organic soil material. The Kratka soils are poorly drained and occupy wet depressions.

The Blomford soil has rapid permeability in the surface and subsurface layers and moderate permeability in the subsoil and underlying material. Surface runoff is slow. Natural fertility and organic matter content are low. The available water capacity is moderate. Depth to the seasonal high water table is 0.5 to 1.5 feet.

Most areas of this soil are used for pasture, hay, or woodland or are vacant. A few areas are used for crops. This soil has fair potential for crops, pasture, and hay. It has fair potential for trees. It has poor potential for sanitary facilities and as building sites.

When drained, this soil has fair suitability for most crops commonly grown in the survey area. During the summer months crop growth may be limited by lack of moisture. Regular return of crop residues helps to conserve moisture. Applying manure, growing legumes and grasses, and fertilizing are ways of increasing the organic matter content and fertility of the soil. In spring, field operations are hampered by wet soil conditions.

This soil has fair suitability for pasture and hay. Proper stocking and weed control will help maintain the more desirable grasses. Liming, fertilization, and rotation graz-

ing are also good management practices. During the summer months production of forage is low and supplemental pasture may be necessary.

This soil has fair suitability for trees. Equipment limitations and seedling mortality are moderate. Although plant competition is severe, new plantings respond favorably after removal or control of competing vegetation.

Because of wetness, this soil is poorly suited to sanitary facilities and as building sites. During wet periods, water moves rapidly through the sandy mantle but is slowed by the less permeable underlying material and forms a perched zone of water saturation. This may result in wet basements and malfunctioning septic tank absorption fields. If this soil is to be used for building, tile needs to be placed around foundation footings and connected to an adequate outlet, or the foundation needs to be placed above the water level. Parking lots, roads, utilities, and foundations are subject to structural damage from frost heave unless specially designed. Septic tank absorption systems also need to be specially designed. Lawns, trees, and shrubs are difficult to establish on this soil.

This soil is in capability subclass IIIw and woodland suitability group 2w.

174C—Gale silt loam, 6 to 15 percent slopes. This moderately sloping to moderately steep soil is well drained. It occurs on side slopes of bedrock controlled uplands. This soil formed mainly in a mantle of loess, 20 to 40 inches thick, over the bedrock. Individual areas range from 5 to 30 acres and are irregular in shape.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is about 22 inches thick. The upper part is dark brown and dark yellowish brown silt loam. The lower part is dark yellowish brown and yellowish brown fine sandy loam. The underlying material is white to brownish yellow sandstone bedrock. The sandstone is usually very soft but may be hard in a few locations. In small areas slope is less than 6 percent or more than 15 percent.

Included in mapping are small areas of well drained Baytown and Ostrander soils. The Baytown soils have a darker colored surface layer. Ostrander soils formed in loess mantled glacial till.

Permeability of the Gale soil is moderate. Surface runoff is medium to rapid. The available water capacity is moderate. Natural fertility is medium, and organic matter content is low. This soil has a moderate shrink-swell potential.

This soil is used mostly for crops or pasture. It has good potential for small grains and grass and legume hay and pasture. It has fair potential for corn and soybeans. It has good potential for woodland. It has good potential as building sites and poor potential for sanitary facilities.

The suitability of this soil to small grains is fair. A severe hazard of erosion exists if corn and soybeans are grown. Where cultivated crops are grown, erosion needs to be controlled. Stripcropping, mulch tillage, or contour farming should be used on the stronger slopes. Minimum tillage or a crop rotation containing forages helps to control erosion. Minimum tillage and the regular return of crop residue to the soil also improve fertility, increase water infiltration rate, and increase organic matter content.

The use of this soil for hay or pasture is an effective means of controlling erosion. Proper stocking, rotation grazing, and weed control help to keep the pastures and soil in good condition. Liming may be necessary in some areas to obtain optimum growth of alfalfa. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to trees. Seedling mortality is generally low. Tree seeds, seedlings, and cuttings survive and grow well if competing vegetation is controlled. Control can be accomplished by spraying, cutting, or girdling. Because erosion is a hazard on the stronger slopes, a soil cover of some kind should be maintained whenever possible. Equipment use is generally not restricted in kind or time of year.

This soil is suitable building sites although bedrock is close to the surface. The bedrock generally is soft and easy to excavate for foundations or installation of utilities. There are hard strata in some areas, however. Volume changes in soil moisture are moderate. Soil strength is low. This soil is highly susceptible to frost heave. Roads, streets, sidewalks, and parking lots may be damaged by frost action unless adequately designed. This soil is easily eroded. Increased runoff from roofs and streets can cause severe gullying unless properly channeled.

Septic tank absorption fields function in this soil. The moderate depth to bedrock and, in places, slope limit this use, however. Septic systems need to be specially designed to prevent pollution of ground water supplies. Lawns, trees, and shrubs are generally easy to establish and maintain.

This soil is in capability subclass IIIe and woodland suitability group 2o.

174F—Gale silt loam, 25 to 50 percent slopes. This very steep soil is well drained. It occurs on side slopes of bedrock controlled uplands. It formed mainly in a mantle of loess 20 to 40 inches thick over bedrock. Individual areas range from 5 to 30 acres and are irregular in shape.

Typically, the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsoil is about 17 inches thick. The upper part is dark yellowish brown silt loam. The lower part is brown sandy loam. The underlying material is weakly cemented sandstone. Limestone bedrock is near the surface of the upper part of the slope in some areas and outcrops of sandstone bedrock are in others. In some areas slope is less than 25 percent or more than 50 percent. Thin strata of glacial till or outwash occur between the silt mantle and the bedrock in some delineations.

Included in mapping are small areas of Dorerton and Mahtomedi Variant soils. The Dorerton soils are underlain by limestone bedrock and occur on the upper back slopes and shoulder slopes. The Mahtomedi Variant soils formed in a sandy mantle over soft sandstone bedrock.

Permeability of the Gale soil is moderate. Surface runoff is very rapid. The available water capacity is moderate. Natural fertility is medium, and the organic matter content is low. This soil has a moderate shrink-swell potential.

Most areas remain in native hardwood forests. This soil has poor potential for cultivated crops. It has fair potential for woodland. It has poor potential for sanitary facilities and building site development. It has good potential for woodland wildlife habitat.

This soil is poorly suited to cultivated crops because of the steep slopes and severe hazard of erosion. Some areas are suitable for wooded pasture; however, steep slopes restrict access of machinery for renovation and seeding of desirable pasture grasses.

This soil has fair suitability for trees. Seedling mortality is slight on north- and east-facing slopes and moderate on south- and west-facing slopes. Site preparation and weeding are needed to reduce competition from undesired plants, but the use of heavy machinery is difficult on the steep slopes. A protective cover of vegetation should be kept on this soil to prevent erosion.

This soil is poorly suited to sanitary facilities and as building sites because of the steep slopes. Where it must be used for building, designing the buildings to fit the slopes can preserve the natural landscape and at the same time reduce the amount of grading needed and decrease erosion and sedimentation. This soil has high susceptibility to frost heave and has low strength. The bedrock generally is soft and easy to excavate for foundations or installation of utilities. However, there are hard strata in some areas. This soil is easily eroded and needs protection from erosion.

This soil is well suited to woodland wildlife habitat. If used for this purpose, areas should be managed to protect existing habitat and to maintain or improve its quality. Management for wildlife habitat also increases the scenic value of the area.

This soil is in capability subclass VIIe and woodland suitability group 2r.

177B—Gotham loamy sand, 1 to 6 percent slopes. This very gently undulating to undulating soil is well drained. It is on knolls and side slopes of pitted outwash plains and in areas of collapsed alluvium. Delineations are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is dark brown loamy sand about 9 inches thick. The subsurface layer, about 11 inches thick, is dark brown loamy sand. The subsoil is about 13 inches thick. The upper part is brown loamy sand and has about 3 percent more clay than the subsurface layer. The lower part is brown loamy sand. The underlying material is brown sand and loamy sand that has dark reddish bands. In some areas the underlying material lacks the dark reddish bands. Slope is more than 6 percent in some areas.

Included with this soil in mapping are small areas of Chetek, Anoka, Mahtomedi, and Zimmerman soils. The Chetek soils are somewhat excessively drained. They have a thin sandy loam surface layer and are underlain by sand and gravel. The Anoka soils are well drained. They formed in fine and very fine sand and have yellower hues than the Gotham soil. Mahtomedi soils are excessively drained and have steeper slopes. They formed in gravelly sandy outwash, whereas the Gotham soil formed in loamy sand. The excessively drained Zimmerman soils have loamy sand bands with an aggregate thickness of less than 6 inches above a depth of 60 inches. The included soils occupy less than 10 percent of the mapped areas.

Permeability of the Gotham soil is rapid. Surface runoff is slow. Available water capacity, organic matter content, and natural fertility are low.

Most areas of this soil are used for crops and pasture. It has fair to poor potential for crops, pasture, and woodland. It has poor potential for most sanitary facilities and good potential as building sites.

Due to its low available water capacity and low natural fertility, this soil is best suited to early-maturing crops such as small grains. They make better use of early spring soil moisture than later crops. Minimum tillage, returning crop residues to the soils, and forage crops in a rotation will help to improve the fertility and increase the water holding capacity of the soil. This soil blows easily, and a protective cover of crop residue will also reduce soil blowing. Fertilization is needed to offset the low natural fertility. This soil is well suited to irrigation, although the rapid intake and low retention of water are management concerns.

The production of pasture is fair in spring and fall but is low during the hot summer months. Proper stocking, rotation grazing, fertilization, and weed control help to maintain an adequate cover of desirable plant species. Overgrazing must be prevented because this soil can erode easily if adequate vegetative cover is not maintained. Where planting is necessary to improve stands, more drought resistant species are desirable.

This soil has fair suitability for woodland. Seedling mortality can be high in years of below-normal rainfall. Furrow planting or planting in existing vegetation reduces soil blowing and seedling damage caused by blowing sand.

This soil is well suited to building site development. Sidewalls have poor stability and may cave in. This can be prevented with temporary retaining walls. Septic tank absorption fields function well in this soil, but the pollution of the underground water supplies and nearby lakes and streams is a hazard unless special systems are installed. Lawns, trees, and shrubs are difficult to establish on this soil and require frequent watering and fertilization.

This soil is in capability subclass IVs and woodland suitability group 3s.

177C—Gotham loamy sand, 6 to 12 percent slopes. This gently rolling soil is well drained. It is on knolls and side slopes of pitted outwash plains and in areas of collapsed alluvium. Individual areas are irregular in shape and range from 10 to 80 acres.

Typically, the surface layer is dark brown loamy sand about 6 inches thick. The subsurface layer, about 5 inches thick, is dark yellowish brown loamy sand. The subsoil, about 21 inches thick, is brown loamy sand and has about 3 percent more clay than the subsurface layer. The underlying material is dark brown sand in which as much as 40 percent of the soil mass is thin (1/4- to 1-inch) reddish brown bands of loamy sand or sandy loam. In some areas the underlying material lacks the reddish bands. In places slope is less than 6 percent or more than 12 percent.

Included with this soil in mapping are small areas of Anoka, Brill, Chetek, Mahtomedi, and Rosholt soils. The Anoka soils are well drained and formed in fine sand and very fine sand. The Brill soils are moderately well drained. They occupy the lower areas on the landscape and have a silty mantle over sand and gravel. The Chetek soils are somewhat excessively drained. They have a thin sandy loam surface layer and are underlain by sand and gravel. The Mahtomedi soils are excessively drained. They are on the steeper side slopes and formed in gravelly sandy outwash. The Rosholt soils are well drained and formed in a loamy mantle over sand and gravel. These soils occupy less than 10 percent of the mapped area.

Permeability of this Gotham soil is rapid. Surface runoff is medium. The available water capacity, organic matter content, and natural fertility are low.

This soil is used mainly for small grains and hay. It has poor potential for crops and fair potential for pasture and woodland. It has poor potential for sanitary facilities and good potential as building sites.

This soil is poorly suited to crops because of its low available water capacity and low natural fertility and the severe erosion hazard. Early-maturing crops, such as small grains, usually make best use of the early spring moisture. Fertilization is needed to offset the low natural fertility. This soil is well suited to irrigation, although the rapid intake and low retention of water are management concerns. Farming on the contour and leaving crop residue on the surface help to reduce erosion. Green manure crops help to increase the available water capacity and the fertility of the soil.

The production of pasture is fair in spring and fall but is very low during the hot summer months. Overgrazing must be prevented, because this soil erodes easily if not adequately covered with vegetation. Proper stocking, rotation grazing, fertilization, and weed control will keep the less productive plant species and weeds from invading the pastures.

This soil has fair suitability for trees. Seedling mortality is high because the soil is droughty. Seedling survival generally is low in years of below average rainfall. A protective soil covering helps to reduce the damage to young seedlings caused by soil blowing. Furrow planting or planting in existing vegetation will reduce erosion and conserve soil moisture by reducing runoff.

This soil is well suited to building site development. Because gullies can easily develop from the increased runoff from roofs and streets, erosion should be controlled during construction. Sidewalls have poor stability and may cave in unless prevented from it by temporary retaining walls.

Septic tank absorption fields function well in this soil, but the pollution of underground water supplies and nearby lakes and streams is a hazard unless special systems are installed. Filter fields become more difficult to lay out as the slope steepens. Lawns, trees, and shrubs are difficult to establish on this soil and require frequent watering and fertilization.

This soil is in capability subclass VIs and woodland suitability group 3s.

177D—Gotham loamy sand, 12 to 20 percent slopes. This hilly to steep soil is well drained. It is on convex knolls and side slopes in areas of collapsed alluvium and on pitted outwash plains. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is very dark grayish brown loamy sand about 5 inches thick. The subsurface layer is dark brown loamy sand about 4 inches thick. The subsoil is about 18 inches thick. The upper part is brown loamy sand. The lower part is strong brown loamy fine sand and has about 3 percent more clay than the subsurface layer. The underlying material is strong brown sand and loamy sand in which as much as 40 percent of the soil mass is thin (1/4- to 1-inch) dark brown bands of loamy sand or sandy loam. In some areas the underlying material lacks the dark brown bands. In places slope is less than 12 percent or more than 20 percent.

Included with this soil in mapping are small areas of Anoka and Chetek soils. The Anoka soils are well drained and formed in fine sand and very fine sand. The Chetek soils are somewhat excessively drained. They have a thin sandy loam surface layer and are underlain by sand or sand and gravel.

Permeability of this Gotham soil is rapid. Surface runoff is rapid to very rapid. The available water capacity, organic matter content, and natural fertility are low.

Most of this soil is pasture and woodland. It has fair potential for this use. This soil has poor potential for sanitary facilities and fair potential as building sites.

This soil is best suited to pasture and hay. It generally is not suited to crops. The hazards of drought and erosion are severe due to the low available water capacity and steep slopes. The production of pasture is fair in spring and fall but is very low during the hot summer months. Proper stocking, rotation grazing, fertilization,

and weed control help to maintain the more desirable plant species. Overgrazing must be prevented because this soil erodes easily when not covered with vegetation.

This soil has fair suitability for woodland. Seedling survival of planted stock is good if furrowing and scalping are used in preparing the seedbed and if rain follows planting. Furrow planting or planting in existing vegetation will reduce erosion and conserve moisture by reducing runoff. Plant competition is slight, and equipment limitations are moderate.

This soil is suitable as building sites although the slope increases the difficulty of preparing the site, installing and maintaining roads and streets, and installing utilities. Sidewalls of excavations have poor stability and may cave in during excavation or installation of underground utilities. This can be prevented by temporary retaining walls. Erosion needs to be controlled during construction. The increased runoff from roads and streets can cause severe erosion. Retaining walls and land shaping help to make desirable homesites.

Slope limits the use of this soil for septic tank absorption fields. Also, downslope seepage of effluent from septic tanks is a severe hazard and may pollute underground water supplies and nearby lakes and streams. Vegetation is difficult to establish and maintain on this soil because of its steep slope and droughtiness. If vegetation is established it requires frequent watering and fertilization.

This soil is in capability subclass VIs and woodland suitability group 3s.

189—Auburndale silt loam. This is a level to depressional, poorly drained soil. It formed in 30 to 45 inches of loess over glacial till on till plains and moraines. Individual areas are irregular in shape and range from 5 to 25 acres. This soil is subject to frequent flooding by runoff from adjacent stronger slopes.

Typically, the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is gray, mottled silt loam about 5 inches thick. The subsoil is about 33 inches thick. The upper part is light brownish gray and gray, mottled silt loam. The lower part is gray, mottled silt loam. The underlying material is reddish brown, mottled sandy loam. In some areas the silty mantle is less than 30 inches thick. In some areas the surface layer is darker colored.

Included with this soil in mapping are small areas of Cathro and Freer soils. Cathro soils formed in an organic mantle over glacial till. Freer soils are somewhat poorly drained and occur on small rises.

This Auburndale soil has moderate or moderately slow permeability. Surface water is ponded unless drainage is provided. The available water capacity is high. Natural fertility is medium, and the organic matter content is high. The seasonal high water table is commonly less than 1 foot below the surface in undrained areas.

Some areas of this soil are farmed, but most areas are not drained and are used for pasture, hay, or wildlife habitat. If drained, this soil has good potential for crops, pasture, and hay. It has poor potential for woodland. This soil has poor potential for sanitary facilities and as building sites. It has good potential for wetland wildlife habitat.

This soil is well suited to row crops, small grains, and forage if adequate drainage is provided. After drainage, the rooting zone is deep. Adequate tile outlets are lacking in many areas. Unless the soil has been drained, it seldom dries to the proper moisture content for tillage.

If drained, this soil is well suited to pasture. Grazing when the soil is too wet will cause surface compaction and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep pasture and soil in good condition.

This soil is poorly suited to woodland. The high water table is the major hazard. Plant competition, seedling mortality, and windthrow are severe. Trafficability is very poor after heavy rains and after snowmelt.

This soil is well suited to wetland wildlife habitat. If the watershed is large enough, this soil is favorable for pond reservoirs. Wetland food and cover plants can be expected to grow well.

Because of wetness, this soil is poorly suited to building site development. Basements are likely to be wet unless the water table is lowered or the foundations are placed above the water table. Unless the water table is lowered, the hazard of frost heaving is high. Streets, driveways, and parking lots are subject to heaving and cracking unless they are carefully designed.

This soil is poorly suited to septic tank absorption fields because of the high seasonal water table, the restricted permeability, and flooding hazards. If it is adequately drained, trees, grasses, and shrubs are easy to establish.

This soil is in capability subclass IIIw and woodland suitability group 3w.

225—Nessel fine sandy loam, 1 to 4 percent slopes. This gently undulating soil is moderately well drained. It is on slight rises, low knolls, and broad tops of low-relief hills on ground and end moraines. Delineations are irregular in shape and cover 5 to 30 acres.

Typically, the surface layer is very dark gray fine sandy loam about 4 inches thick. The subsurface layer, about 9 inches thick, is dark grayish brown fine sandy loam. The subsoil is about 28 inches thick. The upper part is grayish brown and brown fine sandy loam. The lower part is mottled brown loam. The underlying material is light olive brown, mottled fine sandy loam.

Included with this soil in mapping are small areas of well drained Braham soils that have a sandy surface layer and subsoil; well drained Hayden soils upslope from Nessel soils; and somewhat poorly drained Dundas soils downslope from Nessel soils. These soils make up less than 10 percent of the mapped unit.

Permeability of this Nessel soil is moderate. Surface runoff is slow. The available water capacity is high. Natu-

ral fertility is medium, and the organic matter content is moderate. The seasonal high water table is at a depth of 3 to 5 feet.

Most areas of this soil are farmed. It has good potential for crops, pasture, and woodland. It has poor potential for sanitary facilities and fair potential as building sites.

This soil is well suited to crops. Most areas are used to grow corn and soybeans. If this soil is worked when too wet, it is easily compacted and becomes hard and cloddy upon drying. Fall plowing permits clods to freeze and thaw in winter and produces a spring seedbed of improved tilth. Returning crop residues to the soil and using forage crops in the rotation help to maintain soil tilth and fertility.

This soil is well suited to pasture and hay. Planting recommended and adapted species, fertilizing, rotation grazing, and weed control help to establish and maintain a cover of desirable plants. Supplemental pasture of warm-season grasses may be needed late in summer.

This soil is well suited to trees, and a few small areas remain in woodlots. Seedlings survive and grow well if competing vegetation is controlled or removed. Site preparation and girdling, spraying, or cutting are good methods of controlling competing vegetation. There are no limitations or hazards to harvesting.

This soil has fair suitability as building sites if the wetness is controlled. Where this soil is used for building, drain tile should be installed around basement footings to control the level of the water table. Where there is no adequate tile outlet, the foundation needs to be placed above the water table to prevent wet basements. This soil has low strength. It is highly susceptible to frost action and to moderate volume changes with changes in soil moisture. Streets, roads, and sidewalks may heave unless they are carefully designed.

This soil is poorly suited to septic tank absorption fields due to the seasonal high water table and restricted permeability. Lawns, trees, and shrubs are easy to establish and maintain on this soil.

This soil is in capability class I and woodland suitability group 2o.

259B—Grays silt loam, 2 to 6 percent slopes. This gently sloping soil is moderately well drained. It is on lake plains. Individual areas range from 5 to 30 acres and are irregular in shape.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsurface layer is grayish brown silt loam about 3 inches thick. The subsoil is about 37 inches thick. The upper part is dark brown silty clay loam. The lower part is brown, mottled silty clay loam. The underlying material is calcareous brown silt loam. In some places the surface layer is very fine sandy loam. In a few areas the subsoil is clay.

Included with this soil in mapping are small areas of Barronett soils which are poorly drained and occur in drainageways and depressions.

The permeability of this Grays soil is moderate. Surface runoff is slow. The available water capacity is high. The natural fertility is medium, and the organic matter content is low. This soil has a seasonal water table at a depth of 4 to 6 feet.

Most areas of this soil are used for farming. This soil has good potential for crops and woodland. It has poor potential for sanitary facilities and fair potential for building site development.

The main management needs are maintenance of tilth and control of erosion. Applying manure, growing grasses and legumes, and proper fertilization maintain tilth and fertility. Using minimum tillage, winter cover crops, and grassed waterways reduces water erosion. Contour plowing may reduce erosion on some long slopes. Fall tillage enables clods to be broken by frost action and produces a spring seedbed with improved tilth. This soil warms up early in the spring and can be worked soon after rainfall.

This soil is well suited to pasture and hay. Planting recommended and adapted species, fertilizing, rotation grazing, and weed control help to establish and maintain a cover of desirable plants. Supplemental pasture of warm-season grasses may be needed late in summer.

This soil is well suited to trees. Control of competing vegetation is necessary and can be accomplished by spraying or girdling trees or by site preparation. Trafficability is poor when the soil is wet, and the use of some heavy equipment may be restricted early in spring or after heavy rains. It may be necessary to control runoff from adjacent stronger slopes to prevent erosion.

This soil has fair suitability as building sites. Where it is used for building, drain tile should be installed around basement footings to prevent water from seeping into basements. Where an adequate tile outlet is lacking, the foundation needs to be placed above the water table. This soil has low strength. It is highly susceptible to frost action and to moderate volume changes with changes in soil moisture. Streets, roads, and sidewalks may heave unless they are carefully designed and placed on more suitable base material. This soil is poorly suited to septic tank absorption fields because it has a seasonal high water table and restricted permeability. Lawns, trees, and shrubs are easy to establish and maintain on this soil.

This soil is in capability subclass IIe and woodland suitability group 1o.

264—Freeon silt loam, 1 to 4 percent slopes. This gently undulating soil is moderately well drained. It formed in 15 to 30 inches of loess over glacial till on till plains and moraines. Individual areas are irregular in shape and range from 5 to 30 acres.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsurface layer is grayish brown silt loam about 4 inches thick. The subsoil is about 42 inches thick. The upper part is dark yellowish brown silt loam. The middle part is yellowish brown and dark brown, mottled silt loam. The lower part is reddish

brown sandy loam. The underlying material is reddish brown sandy loam. In some areas the silty mantle is more than 30 inches thick. In some areas there is no silty mantle and the soil formed entirely in glacial till.

Included with this soil in mapping are small areas of Santiago, Kingsley, Freer, and Auburndale soils. Santiago soils are well drained and occupy the more sloping areas. Freer soils are somewhat poorly drained and Auburndale soils are poorly drained, and they occupy drainageways and depressions. Kingsley soils are well drained, are not loess mantled, and occur in the more sloping positions on the landscape.

Permeability of the Freeon soil is moderate in the surface layer and upper part of the subsoil and moderately slow in the lower part of the subsoil and the underlying material. Surface runoff is slow. The available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The seasonal high water table is at a depth of 2 to 3 feet.

Most areas of this soil are farmed, but some areas remain in woodland and others have been used for homesites. This soil has good potential for crops, pasture, and hay. It has good potential for woodland. It has poor potential for sanitary facilities and fair potential as building sites.

This soil is well suited to all crops that are grown in the survey area, although most areas are used to grow corn and soybeans. This soil warms up slowly in spring and dries slowly after rains. It can be satisfactorily tilled only within a narrow range of moisture content. Under good management this soil can be maintained in good tilth by such practices as minimum tillage, tilling at the right moisture content, and returning large amounts of crop residue to the soil. Fall tillage enables clods to be broken by freezing and thawing in winter. Stones and cobbles frequently occur in the till material. The main management need is maintaining soil tilth, organic matter, and fertility.

This soil is well suited to pasture and hay. Grazing when the soil is too wet will cause surface compaction. Proper stocking, rotation grazing, fertilization, and weed control help to keep the pasture and soil in good condition. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to trees. Seedling mortality, equipment limitations, and the hazard of erosion are slight. Plant competition is severe. Clearing, spraying, or other site preparation is needed to eliminate brush.

This soil is suitable as building sites if wetness is controlled. Where it is used for building, drain tile should be installed around foundations or the foundation should be placed above the level of the water table. This soil is moderately susceptible to frost action. Moderate volume changes occur with changes in moisture in the subsoil, and strength is low. Streets, roads, and sidewalks tend to heave unless they are carefully designed.

This soil is poorly suited to sanitary facilities. The major limitation for septic tank absorption fields is the seasonal high water table at a depth of 3 to 5 feet. During wetter seasons septic tank absorption systems may not function properly. The moderately slow permeability of the subsoil and underlying material is also a limitation. Trafficability is poor on this soil after rains. Lawns, shrubs, and trees are easy to establish.

This soil is in capability class I and woodland suitability group 2o.

265—Soderville loamy fine sand. This is a nearly level, somewhat poorly drained soil. It occupies flats, drainageways, and depressions on outwash plains. Individual areas range from 5 to 35 acres and are irregular in shape.

Typically, the surface layer is very dark grayish brown loamy fine sand about 8 inches thick. The subsurface layer is grayish brown loamy fine sand about 9 inches thick. The subsoil, about 10 inches thick, is dark brown fine sandy loam. Below this are several alternating layers of light gray and brown mottled loamy fine sand and fine sand. The underlying material is very pale brown, mottled fine sand. In some places the underlying material is medium sand. In places, the surface layer is fine sand.

Included with this soil in mapping are small areas of Anoka, Zimmerman, and Isanti soils. Anoka soils are well drained, and Zimmerman soils are excessively drained. Both occur on slight rises. Isanti soils are very poorly drained and occur in the deeper parts of some depressions or waterways.

Permeability of the Soderville soil is rapid. Surface runoff is very slow. The available water capacity is low. The natural fertility and the organic matter content are low. A seasonal high water table is commonly 2 to 4 feet below the surface.

Most areas of this soil are used for crops and pasture. Some areas are in woodlands, and others are used for urban development. This soil has fair potential for pasture and crops and for woodland. It has poor potential for sanitary facilities and fair potential for building site development.

Crop growth on this soil is limited by wetness, except in drained areas. Drainage is not needed if adjacent lower lying soils are drained; however, good drainage outlets are often lacking. Soil blowing is a hazard which can be reduced by minimum tillage or maintaining a cover of crop residues. The use of this soil for pasture is limited by low production during dry summer months. It is difficult to keep a good vegetative cover, and overgrazing should be avoided because this soil blows easily.

This soil has fair suitability for trees. Low natural fertility and low available water capacity are limitations. Before planting, the site needs to be prepared to control competing vegetation. Seedling mortality is moderate to severe. The survival of seedlings depends mainly on available moisture and generally is good if it rains soon after planting. It is also important to mulch during planting and maintain a protective sod cover. Seedlings are also subject to damage from soil blowing. Planting trees

in furrows reduces soil blowing and conserves soil moisture.

This soil has fair suitability as building sites if wetness is controlled. It is poorly suited to sanitary facilities. If buildings are constructed on this soil, either the water table should be lowered or the foundation should be placed above the water table. Excavations and trenches are easily made; however, sidewalls are subject to collapsing and require temporary retaining walls. Septic tank absorption fields function poorly in this soil because of the high water table. They may pollute the ground water and nearby lakes and streams. Lawns, trees, and shrubs are difficult to establish on this soil.

This soil is in capability subclass IVw and woodland suitability group 3s.

266—Freer silt loam. This is a level, somewhat poorly drained soil in plane or slightly concave positions on till plains and moraines. Individual areas are irregular in shape and range from 5 to 30 acres.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is grayish brown, mottled silt loam about 4 inches thick. The subsoil is about 25 inches thick. The upper part is brown and grayish brown, mottled silt loam. The middle part is grayish brown, mottled loam. The lower part is reddish gray, mottled sandy loam. The underlying material is reddish brown, mottled sandy loam. In some areas the silty mantle is more than 30 inches thick.

Included with this soil in mapping are small areas of Freeon and Auburndale soils. The Freeon soils are moderately well drained and occur on slight rises. The Auburndale soils are poorly drained and occupy slight depressions.

This Freer soil has moderate permeability in the silty mantle and moderately slow permeability in the underlying glacial till. Surface runoff is very slow. The available water capacity is high. Natural fertility is medium, and organic matter content is low. The seasonal high water table is commonly 1 to 3 feet below the surface in undrained areas.

Most areas of this soil are farmed, but some areas are used for pasture, hay, or woodland. When drained, this soil has good potential for crops and pasture. It has fair potential for woodlands. It has poor potential for sanitary facilities and fair potential for building site development.

This soil is well suited to row crops, small grains, and forages if adequate drainage has been provided. Unless the soil has been drained, it seldom dries to the proper moisture content for tillage. Because it has low organic matter content, it tends to seal over during heavy rains and form a hard crust upon drying. The return of crop residues to the soil improves fertility and tilth, increases water infiltration, and helps maintain organic matter content.

This soil is well suited to pasture and hay. Grazing when it is too wet will cause surface compaction. Proper stocking, rotation grazing, fertilization, and weed control help to keep the pasture and soil in good condition. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil has fair suitability for woodland. Seedling mortality and equipment limitations are slight. Equipment use is not recommended in early spring or after heavy rainfall. Plant competition is severe, and the hazard of erosion is slight. Clearing, spraying or other site preparation is needed to eliminate brush.

This soil is suitable as building sites if wetness is controlled. Potential frost heave is high in the upper 2 to 3 feet of the soil. Streets, roads, and sidewalks tend to heave and crack unless they are carefully designed. If this soil is used for building, artificial drainage is needed to control the water table or the foundation needs to be built above the water table. This soil is poorly suited to septic tank absorption fields because of wetness and the moderately slow permeability of the underlying material. Lawns, trees, and shrubs are easy to establish on this soil.

This soil is in capability subclass IIw and woodland suitability group 2o.

298—Richwood silt loam, 0 to 2 percent slopes. This level soil is well drained and is on silt mantled outwash plains. Individual areas range from 10 to 200 acres and are irregular in shape.

Typically, the surface layer is very dark gray silt loam about 11 inches thick. The subsurface layer, about 9 inches thick, is very dark grayish brown silt loam. The subsoil is about 31 inches thick. The upper part is dark brown silt loam. The middle part is dark yellowish brown silty clay loam. The lower part is dark yellowish brown and brown silt loam. The underlying material is dark yellowish brown and yellowish brown sand. In some places the silty mantle is less than 40 inches thick. Also, in some places, the underlying sand is redder.

Included with this soil in mapping are small areas of Lindstrom soils which are well drained and lack sand within 60 inches of the surface.

Permeability of the Richwood soil is moderate in the surface layer and subsoil and is rapid in the underlying material. Surface runoff is very slow. The available water capacity is high. The natural fertility and organic matter content are high.

Most areas of this soil are in crops. It has good potential for crops and pasture. This soil has poor potential for most sanitary facilities and good potential as building sites.

This soil is well suited to all crops commonly grown in the area. Returning crop residue to the soil is desirable to maintain tilth and fertility and reduce soil blowing. This soil is well suited to hay and pasture. Pastures and hay can be improved by fertilizing, by seeding suitable grasses and legumes, and by proper stocking.

This soil is well suited to building site development. The upper silty mantle has low strength and is highly susceptible to frost action, therefore more suitable base

material should be used for roads and streets. Moderate changes occur in the volume of the subsoil with changes in soil moisture.

This soil is well suited to septic tank absorption fields. Because the underlying material is coarse textured, however, the pollution of ground water as well as nearby lakes and streams is a hazard unless special absorption systems are installed. Lawns, trees, and shrubs are relatively easy to establish and maintain.

This soil is in capability class I. It is not placed in a woodland suitability group.

298B—Richwood silt loam, 2 to 6 percent slopes. This gently sloping soil is well drained and is on silt mantled outwash plains. Individual areas are irregular in shape and range from 50 to 150 acres.

Typically, the surface layer is very dark gray silt loam about 10 inches thick. The subsurface layer, about 4 inches thick, is dark grayish brown silt loam. The subsoil is dark yellowish brown silt loam about 31 inches thick. The underlying material is dark yellowish brown and yellowish brown sand. In some places the silty mantle is less than 40 inches thick. In other areas the underlying sands are reddish.

Included with this soil in mapping are small areas of well drained Campia and Lindstrom soils. Campia soils formed in deep silty sediments. The Lindstrom soils have no sand in the profile and occur in shallow depressions and drainageways.

Permeability of the Richwood soil is moderate in the surface layer and subsoil and is rapid in the underlying material. Surface runoff is slow. The available water capacity, natural fertility, and organic matter content are high.

Most areas of this soil are used for farming. This soil has good potential for crops and pasture. It has fair potential for sanitary facilities and good potential as building sites.

This soil is well suited to all crops grown in the survey area. Crops grown on this soil respond well to fertilization. On long slopes erosion should be controlled by contour farming and management of crop residues. Where length of slope and slope regularity permit, terracing and contour stripcropping are effective means of controlling erosion. In areas where contour stripcropping or terracing is impractical, the use of rough tillage, minimum tillage, and stubble mulching helps to control erosion. This soil is well suited to pasture and hay, and these crops are effective in controlling erosion.

This soil is well suited to building site development. The upper silty mantle has low strength and is highly susceptible to frost action, therefore more suitable base material should be used for roads and streets. Moderate changes occur in the volume of the subsoil with changes in soil moisture.

This soil is well suited to septic tank absorption fields. Because the underlying material is coarse textured, however, the pollution of ground water is a hazard unless special absorption systems are installed. Lawns, trees, and shrubs are relatively easy to establish and maintain.

This soil is in capability subclass IIe. It is not placed in a woodland suitability group.

301B—Lindstrom silt loam, 2 to 4 percent slopes. This very gently sloping soil is well drained. It is in concave positions at the bottom of steep hills. Individual areas are elongated in shape and range from 3 to 100 acres.

Typically, the surface soil is very dark gray silt loam about 37 inches thick. The subsoil is dark yellowish brown and yellowish brown silt loam about 21 inches thick. The underlying material is yellowish brown silt loam. In some areas the underlying material has grayish brown mottles.

Included with this soil in mapping are small areas of Otter, Richwood, and Ripon soils. Otter soils are poorly drained and are in lower concave positions. Richwood soils are underlain by sand and gravel. Ripon soils are underlain by limestone bedrock within a depth of 40 inches.

This Lindstrom soil has moderate permeability. Surface runoff is slow. The available water capacity is very high. Natural fertility is medium, and organic matter content is moderate.

Most areas of this soil are farmed. Some areas too narrow to be practical for farming are pastured or left idle. This soil has good potential for crops, pasture, and hay. It has good potential for sanitary facilities and building site development.

This soil is well suited to crops common to the area. If it is used for crops, there is a hazard of erosion. Minimum tillage, winter cover crops, rotations that include forage crops, and grassed waterways help to prevent excessive soil loss. Crops respond well to a good fertilization program. The application of manure and the growing of legumes and grasses are ways of maintaining soil tilth and fertility.

This soil is well suited to pasture and hay. Productivity is good for all kinds of forage except the wetland species. Grazing when the soil is too wet will cause surface compaction and poor tilth. The use of this soil for pasture or hay is effective in controlling erosion.

This soil is well suited to building site development. Because it is silty, trafficability is poor when this soil is wet. Runoff from surrounding steeper soils may be a hindrance to some engineering uses. This soil is highly susceptible to frost action. Unless roads, streets, sidewalks, and parking lots are carefully designed, they may be damaged by the frost action.

This soil is well suited to septic tank absorption fields. However, permeability is so restricted in places that special design is needed. It is essential that individual sites be carefully investigated. Lawns, trees, and shrubs are generally easy to establish on this soil.

This soil is in capability subclass IIe. It is not placed in a woodland suitability group.

302B—Rosholt sandy loam, 1 to 6 percent slopes. This very gently undulating to undulating soil is well drained. It is on sides and crests of low hills on outwash plains. Individual areas range from 5 to 30 acres and are irregular in shape.

Typically, the surface layer is dark brown sandy loam about 11 inches thick. The subsoil is about 20 inches thick. The upper part is brown sandy loam. The middle part is reddish brown sandy loam. The lower part is reddish brown gravelly loamy coarse sand. The underlying material is yellowish red gravelly sand. In some places the underlying material lacks coarse fragments. The loamy mantle is less than 20 inches thick in places. In some small areas slope is more than 6 percent. In the south and central parts of the survey area the surface layer is thicker and darker colored.

Included with this soil in mapping are small areas of Antigo, Barronett sandy substratum, Brill, and Poskin soils. The Antigo soils are well drained and have silt loam surface and subsurface layers over sand and gravel. The Barronett sandy substratum soils are poorly drained and occupy depressions. The Brill soils are moderately well drained and are in shallow depressions. They have a silt loam surface layer and subsoil over sand and gravel. The Poskin soils are somewhat poorly drained and occur in depressions.

Permeability of the Rosholt soil is moderately rapid in the surface layer and subsoil and is very rapid in the underlying material. Surface runoff is medium. The available water capacity is low. Natural fertility is medium, and the organic matter content is low.

Most areas of this soil are farmed. It has fair potential for crops, pasture, and woodland. It has poor potential for most sanitary facilities and good potential as building sites.

This soil has fair suitability for all crops commonly grown in the survey area. The main limitation is the low available water capacity. Early-maturing crops are well adapted to this soil because they take advantage of early-season moisture. Minimum tillage and return of crop residue to the soil help maintain tilth, increase water available for plants, and increase fertility. Crops grown on this soil respond well to irrigation.

This soil has only fair suitability for permanent pasture or hay because yields are limited by the low available water capacity. It provides good pasture in spring and fall and fair to poor pasture in summer. Proper stocking, pasture rotation, weed control, and timely deferment of grazing help to keep pasture and soil in good condition. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil has fair suitability for trees. Seedling mortality is slight to moderate. Competing vegetation can be controlled by spraying or girdling or by mechanical means such as plowing, disking, or bulldozing. There is no restriction to time of year or type of equipment that can be used.

This soil is well suited to building site development. This soil is moderately susceptible to frost heaving. Roads, streets, and sidewalks are subject to damage unless carefully designed. Sidewalls in the underlying material have poor stability and may cave in during excavation. This can be prevented with temporary retaining walls.

Septic tank absorption fields function well in this soil, but there is a hazard of contamination of underground water supplies unless special systems are installed. It is generally easy to establish lawns, trees, and shrubs on this soil. Additions of water and fertilizer are needed to keep them growing vigorously. This soil is a fair source of sand and gravel for construction.

This soil is in capability subclass IIs and woodland suitability group 2o.

302C—Rosholt sandy loam, 6 to 15 percent slopes. This gently rolling to hilly soil is well drained. It is on sides and crests of hills on pitted outwash plains. Individual areas range from 5 to 40 acres and are irregular in shape.

Typically, the surface layer is very dark gray sandy loam about 5 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown and very dark grayish brown sandy loam. The lower part is brown loamy sand. The underlying material is brown gravelly sand. In some places the loamy layers are less than 20 inches thick. In some farmed areas the surface layer is eroded and may be lacking. The underlying material lacks coarse fragments in places. In some areas slope is less than 6 percent or more than 15 percent. In the south and central parts of the survey area the surface layer is thicker and darker colored.

Included with this soil in mapping are small areas of Antigo, Barronett sandy substratum, Brill, and Poskin soils. The Antigo soils are well drained and formed in a silty mantle over sand and gravel. The Barronett sandy substratum soils are poorly drained and occupy depressions. The Brill soils, which occur in shallow depressions, are moderately well drained and have a silty surface layer and subsoil. The Poskin soils are somewhat poorly drained and occur in depressions and drainageways.

Permeability of the Rosholt soil is moderately rapid in the surface layer and subsoil and very rapid in the underlying material. Surface runoff is medium to rapid. The available water capacity is low. Natural fertility is medium, and organic matter content is low.

Most areas of this soil are farmed or are in woodland. This soil has fair potential for small grains and grass and legume hay and pasture. It has poor potential for corn and soybeans. It has fair potential for woodland. This soil has poor potential for most sanitary facilities and good potential for building site development.

This soil has fair to poor suitability for crops. Droughtiness and the hazard of erosion are the main limitations. It is best suited to early-maturing crops, such as small grains, which take advantage of early-season moisture. Minimum tillage or a crop rotation that contains forage crops helps to control erosion. Erosion control by con-

tour plowing and stripcropping is often difficult on the irregular slopes of this soil. Crops grown on this soil respond well to irrigation although it may erode the steeper areas.

This soil has fair suitability for pasture or hay. Using it for hay or pasture reduces erosion. Droughtiness reduces growth during the summer months, at which time supplemental pasture may be needed. Proper stocking, rotation grazing, and weed control help to keep the pasture and soil in good condition. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil has fair suitability for trees (fig. 9). Seedling mortality is generally low but depends mainly on available moisture. Competing vegetation can be controlled by spraying, cutting, or girdling. Erosion can be controlled by mulching during planting or by keeping a protective vegetative cover on the soil. Equipment use is generally not restricted in kind or time of year.

This soil is well suited to building site development. It is moderately susceptible to frost heave. Roads, streets, and sidewalks are subject to frost damage unless carefully designed. Sidewalls in the underlying material have poor stability and may cave in during excavation for foundations or installation of underground utilities. This can be prevented by temporary retaining walls.

Septic tank absorption fields function well in this soil. There is a possibility, however, that they may pollute underground water supplies and nearby lakes and streams unless specially designed. Lawns, trees, and shrubs are generally easy to establish and maintain. This soil is a good source of sand and gravel for construction.

This soil is in capability subclass IIIe and woodland suitability group 2o.

325—Prebish loam. This is a level, slightly concave, very poorly drained soil. It is in shallow depressions on the margins of large depressions occupied by organic soils and on ground moraines. Delineations are 5 to 30 acres and are irregular in shape. This soil is subject to flooding by runoff from adjacent more sloping areas.

Typically, the surface layer is black loam about 17 inches thick. The subsoil is about 31 inches thick. The upper part is gray, mottled loam. The middle part is olive gray, mottled loam. The lower part is variegated dark brown, reddish brown, and dark gray coarse sandy loam. The underlying material is reddish brown sandy loam. In some areas the surface mantle has up to 15 inches of silty material.

Included with this soil in mapping are small areas of Ronneby, Auburndale, and Cathro soils. The Ronneby soils are somewhat poorly drained and occupy positions slightly upslope from Prebish soils. The Auburndale soils are poorly drained. They have a thick silty surface mantle and occupy depressional areas. The Cathro soils

Figure 9.—Christmas trees on Rosholt sandy loam, 6 to 15 percent slopes. Gale soils are on the steep slopes in the background.

are very poorly drained and have an organic surface layer and loamy underlying material.

The Prebish soil has moderately slow permeability. Surface runoff is ponded or very slow. The available water capacity is moderate. Organic matter content is high, and natural fertility is medium. A seasonal high water table is commonly at or within a foot of the surface.

Most areas of this soil are idle or are used for pasture. A few areas are drained and used for crops. This soil has poor potential for crops and woodland and good potential for pasture. It has poor potential for sanitary facilities and building site development. It has good potential for development of wetland wildlife habitat.

This soil is poorly suited to most crops commonly grown in the survey area. Unless drained, it is generally too wet for good crop production. Because most areas lack adequate drainage outlets, drainage may not be feasible. This soil is well suited to pasture, because it holds moisture well throughout the growing season. Some pastures that are brushy and provide poor grazing need to be cleared and managed to provide better grazing.

This soil is poorly suited to woodland. The seasonal high water table is the major hazard. Plant competition, seedling mortality, and windthrow are severe. Trafficability is very poor after heavy rains and after snowmelt.

This soil is well suited to habitat for wetland wildlife (fig. 10). Pond reservoirs are easy to establish and the desired water level is fairly easy to maintain. Wetland food and cover plants can be expected to grow well.

Because of wetness and flooding, this soil is poorly suited to building site development. Susceptibility to frost heave is high. Streets, roads, and sidewalks tend to heave and crack unless they are carefully designed. Soil strength is low. If this soil is used for building, artificial drainage is needed or the foundations need to be built on fill above the water table. This soil is poorly suited to septic tank absorption fields because of wetness, flooding, and moderately slow permeability.

This soil is in capability subclass IVw and woodland suitability group 3w.

327—Dickman sandy loam, 0 to 2 percent slopes. This nearly level soil is somewhat excessively drained. It is on terraces of major rivers. Individual areas are irregular in shape and range from 40 to 120 acres.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is very dark brown sandy loam about 6 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown sandy loam. The middle part is dark brown loamy sand. The lower part is dark yellowish brown sand. The underlying material is yellowish brown sand. In some places a sandy loam subsurface layer extends to a depth of more than 20 inches. In small areas slope is more than 2 percent.

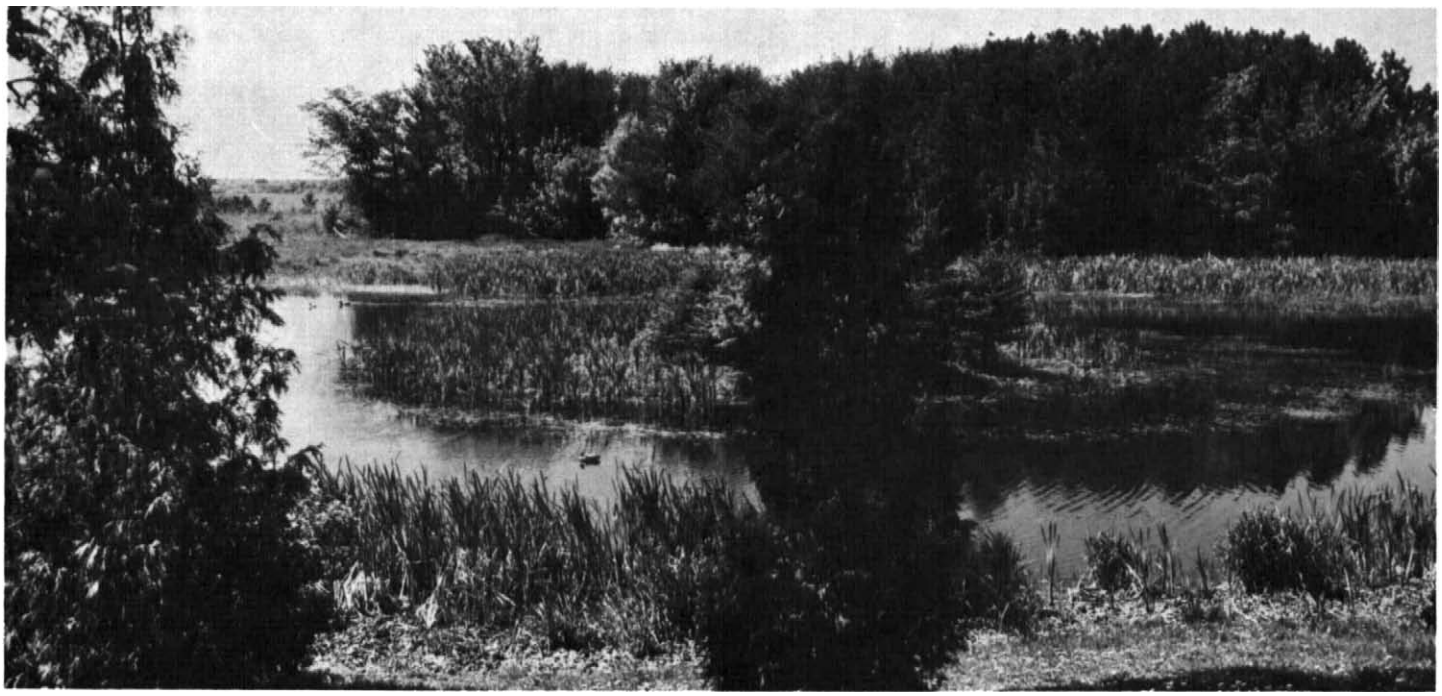

Figure 10.—An island type wildlife pond in an area of Prebish loam.

Included in mapping are small areas of Sparta and Hubbard soils. The Sparta soils are excessively drained and are in convex positions on the landscape. They have a loamy sand surface layer and subsoil. The Hubbard soils are excessively drained. They have loamy sand surface and subsurface layers and formed in coarser sands.

Permeability of the Dickman soil is moderately rapid in the surface layer and subsoil and rapid in the underlying material. Surface runoff is slow. The natural fertility is medium, the organic matter content is moderate, and the available water capacity is low.

Most of this soil is used for crops. It has fair potential for crops, pasture, and hay. It has good potential for building site development and poor potential for most sanitary facilities.

This soil has fair suitability for all farm crops commonly grown in the survey area. The main limitation is the low available water capacity. Early-maturing crops, such as small grains and truck crops, are best suited to this soil because they take advantage of early season moisture. This soil is well suited to irrigation. Windblown sand from this and surrounding soils may damage young plants. Moisture can be conserved and wind erosion controlled by using minimum tillage, maintaining a crop cover during the winter, and returning crop residues to the soil. This soil warms early in spring and dries rapidly after rains.

Because it is droughty, this soil has fair suitability for pasture and hay. More forage is produced by pastures of bromegrass and alfalfa than by pastures of permanent bluegrass. If this soil is used for pasture or hay, drought resistant species may be desirable to improve plant species and potential yield.

This soil is well suited to building site development. This soil is easy to excavate for foundations and underground utilities, but there is danger of sidewalls collapsing. This can be overcome by over-excavation or by installing temporary retaining walls.

Septic tank absorption fields function well in this soil. Unless specially designed and approved systems are installed, however, the pollution of ground water is a hazard. Vegetation is difficult to establish and maintain on this soil. A topdressing of 12 to 18 inches of loamy material is desirable before seeding or laying sod. This soil is generally a fair source of sand.

This soil is in capability subclass IIIs. It is not placed in a woodland suitability group.

327B—Dickman sandy loam, 2 to 6 percent slopes. This gently sloping soil is somewhat excessively drained. It is on terraces of major rivers. Individual areas are irregular in shape and range from 5 to 30 acres.

Typically, the surface soil is very dark grayish brown sandy loam about 7 inches thick. The subsurface layer is very dark brown sandy loam 7 inches thick. The subsoil is about 24 inches thick. The upper part is dark brown sandy loam. The middle part is brown loamy sand. The lower part is brown sand. The underlying material is yellowish brown sand. In a few places the sandy loam subsoil extends to a depth of more than 20 inches. In some areas slope is less than 2 percent or more than 6 percent.

Included in mapping are small areas of Sparta and Hubbard soils. The Sparta soils are excessively drained and are in the more sloping areas. They have a loamy sand surface layer and subsoil. The Hubbard soils are excessively drained. They have a loamy sand surface layer and subsoil and formed in coarser sands than the Dickman soil.

Permeability of the Dickman soil is moderately rapid in the surface layer and subsoil and is rapid in the underlying material. The available water capacity is low, natural fertility is medium, and the organic matter content is moderate.

Most of this soil is cultivated. It has fair potential for most crops. It has fair potential for pasture and hay. It has good potential for building site development and poor potential for most sanitary facilities.

This soil is poorly suited to most crops grown in the survey area. Most areas are used for growing corn or soybeans. Early-maturing crops such as small grains and truck crops are best suited to this soil. Because of shallow depth to sand, erosion seriously reduces the available water capacity. Both water and wind erosion need to be controlled. Minimum tillage, no-till planting, and cover crops help to maintain the organic matter content, reduce soil blowing, and conserve moisture. Field windbreaks will help to control wind erosion. Stubble mulch tillage that keeps the surface rough and trashy is well suited to this soil. A proper fertilization program is needed to offset the medium natural fertility. This soil is suitable for irrigation if an adequate water supply is available.

This soil has fair suitability for pasture and hay. It produces fair pasture in spring and fall, but because of the low available water capacity, it produces little forage during dry summer months. Supplemental pastures may be needed at these times. Planting drought resistant species of pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to building site development. Erosion control is needed both during and immediately following construction. This soil is easy to excavate for foundations and underground utilities, but trenches are subject to collapsing. This can be overcome by over-excavation or by using temporary retaining walls.

Septic tank absorption fields function well in this soil but must be carefully designed to overcome the limitations imposed by slope and the hazard of pollution. Vegetation is difficult to maintain on this soil. A topdressing of loamy material 12 to 18 inches thick is desirable before seeding or laying sod.

This soil is in capability subclass IIIe. It is not placed in a woodland suitability group.

327C—Dickman sandy loam, 6 to 12 percent slopes. This moderately sloping soil is somewhat exces-

sively drained. It occurs on terraces of major rivers. Individual areas range from 5 to 30 acres and are irregular in shape.

Typically, the surface layer is very dark gray sandy loam about 6 inches thick. The subsurface layer is very dark brown sandy loam 6 inches thick. The subsoil is about 15 inches thick. The upper part is dark brown fine sandy loam. The lower part is dark brown sand. The underlying material is brown sand. In some areas the sandy loam surface layer and subsoil combined have a thickness of more than 20 inches. In some areas the slope is less than 6 percent or more than 12 percent.

Included in mapping are small areas of excessively drained Sparta and Hubbard soils. The Sparta soils have a loamy sand surface layer and subsoil. The Hubbard soils formed in coarser sands and contain more gravel than the Dickman soil.

Permeability of the Dickman soil is moderately rapid in the surface layer and subsoil and is rapid in the underlying material. The available water capacity is low, natural fertility is medium, and the organic matter content is moderate.

Most of this soil is cultivated. It has poor potential for most crops but fair potential for small grains and forage crops. It has good potential as building sites and poor potential for most sanitary facilities.

This soil is poorly suited to most crops grown in the survey area. Most areas are used for growing corn or soybeans. Early-maturing crops such as small grains and truck crops are best suited. Both water and wind erosion need to be controlled. Minimum tillage, no-till planting, and cover crops help to maintain organic matter content, reduce soil blowing, and conserve moisture. Field windbreaks will help to control wind erosion. Stubble mulch tillage that keeps the surface rough and trashy is well suited to this soil. Fertilization is needed to offset the medium natural fertility. This soil is suitable for irrigation if an adequate water supply is available.

This soil has fair suitability for pasture and hay. It produces fair pasture in spring and fall, but because of its low available water capacity produces little forage during dry summer months. Supplemental pastures may be necessary at these times. Planting drought-resistant species of pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to building site development. The major limitation is slope. As slope gradient increases the difficulty of utility installation and road construction increases. Designing buildings to fit the landscape can preserve the natural landscape while reducing grading requirements, erosion, and sedimentation. Erosion needs to be controlled during and immediately following construction. It is easy to excavate for foundations and underground utilities, but trenches are subject to collapsing. This can be overcome by over-excavation or by using temporary retaining walls.

Septic tank absorption fields must be carefully designed to overcome the limitations imposed by slope and the hazard of pollution. Lawns, trees, and shrubs are difficult to establish and maintain on this soil. A topdressing of loamy material 12 to 18 inches thick is desirable before seeding or laying sod.

This soil is in capability subclass IVe. It is not placed in a woodland suitability group.

329—Chaska silt loam. This is a level, poorly drained and somewhat poorly drained soil. It occupies plane to slightly concave side slopes in areas of recent alluvial deposits on flood plains of the major streams and rivers. Individual areas are irregular in shape and range from 5 to 100 acres. This soil is subject to frequent flooding from stream overflow.

Typically, the surface layer is very dark gray silt loam about 6 inches thick. The underlying material is stratified, calcareous, multicolored silt loam, very fine sandy loam, and loamy fine sand.

Included with this soil in mapping are small areas of Algansee soils that formed in sandy alluvium. Small areas of very poorly drained soils in oxbows and abandoned channels are in some delineations.

This Chaska soil has moderate permeability. Surface runoff is very slow. The available water capacity is high. Natural fertility is medium, and the organic matter content is moderate. The seasonal high water table is at a depth of 1 to 3 feet. This soil has a high corrosion potential for uncoated steel.

Most of this soil is in a natural state or is parkland. Because of the flooding hazard, this soil has poor potential for crops, pasture, and woodland. It has poor potential for sanitary facilities and as building sites. It has good potential for wetland wildlife habitat. Suitable water habitat is readily available in the nearby streams.

This soil is poorly suited to building site development. Frequent flooding is a hazard to development that can be overcome with extensive diking or land filling. This soil is highly susceptible to frost heaving. It can be used for parks, recreation areas, and wildlife sanctuaries. Where it is less frequently flooded, it is suitable for campsites and picnic areas. Flooding is generally not a severe limitation to these uses, because the period of peak use generally occurs after floodwaters have receded.

This soil is in capability subclass VIw. It is not placed in a woodland suitability group.

340B—Whalan silt loam, 1 to 6 percent slopes. This very gently sloping to gently sloping soil is well drained. It occurs on bedrock controlled uplands. It formed mainly in a mantle of loamy and silty sediments 20 to 40 inches thick over the bedrock. Areas of this soil range from 5 to 40 acres and are irregular in shape.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. The subsoil is about 11 inches thick. The upper part is dark brown loam. The lower part is dark yellowish brown silt

loam. Limestone bedrock is at a depth of 23 inches. In small areas slope is more than 6 percent. Small areas of bedrock outcrop are in some delineations.

Included in mapping are small areas of Ripon and Ostrander soils. Ripon soils formed in silty sediments over limestone bedrock. Ostrander soils do not have bedrock within 60 inches of the surface.

Permeability of the Whalan soil is moderate. Runoff is medium, and the available water capacity is moderate. The natural fertility is medium, and organic matter content is low.

Most of this soil is cropland. It has fair potential for row crops and good potential for small grains and grass and legume pasture and hay. It has good potential for trees. It has fair potential as building sites and poor potential for most sanitary facilities.

Although this soil is subject to erosion and to droughtiness during years of low rainfall, it is suited to all crops commonly grown in the county. Most areas are too small in size, too irregular in shape, or too short of slope to terrace or contour farm. Minimum tillage, returning crop residue to the soil, and forage crops in the rotation reduce erosion and improve the water holding capacity of the soil. This soil is suited to irrigation.

This soil is well suited to pasture and hay production. Pastures of bromegrass and alfalfa produce more forage than pastures of bluegrass. Proper stocking, rotation grazing, fertilization, and weed control reduce the invasion of weeds and less productive grasses into the pastures. Overgrazing should be avoided because it increases the hazard of erosion.

This soil is well suited to trees, and a few small areas remain in woodlots of northern hardwoods. Tree seedlings and cuttings survive and grow well if competing vegetation is controlled. This can be accomplished by spraying, cutting, girdling, or cultivation.

This soil has fair suitability as building sites because of the moderate depth to bedrock. The underlying bedrock requires heavy machinery for excavation. Susceptibility to frost heave is moderate, and roads, streets, and driveways may be damaged unless placed on more suitable base materials. Septic tank absorption fields are difficult to install because of the shallowness to the underlying bedrock. The pollution of ground water is a hazard, because effluent seeps through the cracks in the bedrock unless special systems are installed. Grasses, trees, and shrubs are generally easy to establish.

This soil is in capability subclass IIe and woodland suitability group 2o.

340C—Whalan silt loam, 6 to 12 percent slopes. This moderately sloping soil is well drained. It occurs on bedrock-controlled uplands. It forms mainly in a mantle of loamy and silty sediments 20 to 40 inches thick over the bedrock. Individual areas range from 5 to 40 acres and are irregular in shape.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown loam about 5 inches thick. The subsoil is about 14 inches thick. The upper part is dark yellowish brown loam. The lower part is dark brown loam. Limestone bedrock is at a depth of 26 inches. Small areas of bedrock outcrop in some delineations. In small areas slope is less than 6 percent.

Included in mapping are small areas of Ripon and Ostrander soils. Ripon soils formed in silty sediments over limestone bedrock. Ostrander soils lack bedrock within a depth of 60 inches.

Permeability of the Whalan soil is moderate. Runoff is medium to rapid. The natural fertility is medium. The available water capacity is moderate, and organic matter content is low.

This soil is used mostly for crops and pasture. It has fair potential for crops, for small grains, and for grass and legume pasture and hay. This soil has good potential for trees. It has fair potential as building sites and poor potential for sanitary facilities.

Although this soil is subject to erosion and to droughtiness in dry years, it is suited to all crops commonly grown in the survey area. Most areas are too small in size, too irregular in shape, or too short of slope for terracing or contour farming. Minimum tillage, returning crop residue to the soil, and forage crops in the rotation reduce erosion and improve the water holding capacity of the soil. This soil is suited to irrigation.

This soil has fair suitability for pasture and hay but it may occasionally be droughty during the drier summer months. Pastures of bromegrass and alfalfa produce more forage than pastures of bluegrass. Proper stocking, rotation grazing, fertilization, and weed control reduce invasion of weeds and less productive grasses into the pastures. Overgrazing increases the hazard of erosion.

Tree cuttings and seedlings survive and grow well if competing vegetation is controlled. Control can be accomplished by spraying, cutting, or girdling or by cultivation prior to planting. Furrow planting on the contour or planting in existing vegetation reduces the hazard of erosion.

This soil has fair suitability as building sites because of the moderate depth to bedrock. The underlying bedrock requires large machinery for excavation. There is a moderate hazard of frost heave. Roads, driveways, and parking lots can be expected to be damaged by frost unless placed on more suitable base material. Septic tank absorption fields are difficult to install due to the shallowness of the soil to bedrock. The pollution of ground water is also a hazard because effluent seeps through the cracks in the bedrock unless special systems are installed. Grasses, trees, and shrubs are generally easy to establish.

This soil is in capability subclass IIIe and woodland suitability group 2o.

342B—Kingsley sandy loam, 2 to 6 percent slopes. This undulating soil is well drained. It is on moraines. Slopes are convex. Individual areas range from 5 to 60 acres and are irregular in shape.

Typically, the surface layer is dark brown sandy loam about 8 inches thick. The subsoil is reddish brown sandy loam about 31 inches thick. The underlying material is reddish brown sandy loam. In some places the subsoil and underlying material are loam. The surface layer is silt loam in places. In small areas slope is more than 6 percent.

Included with this soil in mapping are small areas of Freeon, Prebish, Ronneby, and Rosholt soils. The Freeon soils are moderately well drained and are in lower, less sloping positions on the landscape. The underlying materials of well drained Rosholt soils are coarse sand or gravel. Ronneby soils, which occur in shallow depressions, are somewhat poorly drained. The Prebish soils are very poorly drained and are in deep depressions.

Permeability of the Kingsley soil is moderately slow. The available water capacity is moderate. Surface runoff is slow to medium. Natural fertility is medium, and the organic matter content is moderate.

Most areas of this soil are used for farming. Many areas are developed for urban uses. This soil has good potential for crops, hay, and pasture. It has good potential for woodland. It has fair to good potential for most sanitary facilities and good potential as building sites.

This soil is well suited to cultivated crops. It warms fairly early in the spring and dries soon after rains. This soil is fairly easy to till, although surface rocks and pebbles are a nuisance. Erosion may be a hazard on some slopes and can best be controlled by keeping the soil covered with vegetation or crop residues. This can be accomplished by minimum tillage or a rotation containing forage crops. High fertilization rates are needed for high yields of most crops. Liming is usually beneficial.

This soil is well suited to pasture and hay production. Proper stocking, rotation grazing, and weed control help to keep the pasture and soil in good condition. Pastures of bromegrass and alfalfa produce more forage than do pastures of bluegrass. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to trees. Seedling mortality is slight. Clearing, spraying, or other site preparation is needed to eliminate brush and reduce plant competition. Equipment use is generally not restricted in kind or time of year.

This soil is well suited to building site development. This soil has only fair suitability for septic tank absorption fields because of its moderately slow permeability, which can be overcome by increasing the size of the absorption field. Vegetation, such as lawns and trees, is fairly easy to establish.

This soil is in capability subclass IIe and woodland suitability group 2o.

342C—Kingsley sandy loam, 6 to 12 percent slopes. This gently rolling soil is well drained. It is on hillsides and in irregular sloping areas of moraines. Individual areas range from 5 to 30 acres and are irregular in shape.

Typically, the surface layer is grayish brown sandy loam about 6 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown sandy loam. The lower part is reddish brown sandy loam. The underlying material is dark reddish brown sandy loam. In a few areas the original surface layer has been removed by erosion and the present layer is reddish brown sandy loam. In some areas the subsoil and underlying materials are loam. Slopes of less than 6 percent or more than 12 percent are in some delineations.

Included with this soil in mapping are small areas of Freeon, Rosholt, and Ronneby soils. The Freeon soils are moderately well drained and are in lower, less sloping positions on the landscape. Rosholt soils are well drained and have sandy and gravelly underlying materials. Ronneby soils, which occur in depressions, are somewhat poorly drained.

The permeability of this Kingsley soil is moderately slow. The available water capacity is moderate. Surface runoff is medium to rapid. The natural fertility is medium, and organic matter content is moderate.

Large areas of this soil are used as cropland and pasture. Much of it is in woodland. This soil has good potential for crops and grass and legume hay and pasture. It has good potential for woodland. This soil has fair to good potential for most sanitary facilities and good potential as building sites.

This soil is well suited to all crops commonly grown in the survey area. Most areas are used to grow corn and soybeans. Erosion is a severe hazard. Most slopes are too short or too irregular to permit effective contour farming. Minimum tillage, no-till planting, or a rotation containing forage crops also helps to control erosion. This soil is fairly easy to till, although surface rocks and pebbles are a nuisance. High fertilization rates are needed for high yields of most crops.

The use of this soil for permanent pasture and hay is an effective means of controlling erosion. Proper stocking, rotation grazing, and weed control help to keep the pasture and soil in good condition. Overgrazing should be avoided because the soil erodes easily when overgrazed. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to trees. Seedling mortality is slight. Clearing, spraying, or other site preparation is needed to reduce plant competition. Equipment use is generally not restricted in kind or time of year.

This soil is well suited to building site development. Slope is the main limitation, and buildings, septic tank absorption fields, and streets must be carefully designed to overcome it. Septic tank absorption fields function poorly because of the moderately slow permeability, which can be overcome by increasing the size of the absorption field. Lawns, trees, and shrubs are fairly easy to establish.

This soil is in capability subclass IIIe and woodland suitability group 2o.

342D—Kingsley sandy loam, 12 to 18 percent slopes. This hilly soil is well drained. It is on steep, narrow side slopes and knolls on terminal ground moraines. Individual areas range from 5 to 60 acres and are irregular in shape.

Typically, the surface layer is dark brown sandy loam about 3 inches thick. The subsurface layer is grayish brown and dark brown sandy loam about 3 inches thick. The subsoil is reddish brown sandy loam about 19 inches thick. The underlying material is reddish brown sandy loam. In some areas the original surface layer has been removed by erosion and the present surface layer is dark brown sandy loam. In small areas slope is less than 12 percent or more than 18 percent. Some areas have a loam texture throughout.

Included with this soil in mapping are small areas of Freeon, Rosholt, and Ronneby soils. The Freeon soils are moderately well drained and are in lower, less steep positions on the landscape. The Rosholt soils are well drained and contain sand and gravel in the underlying material. The Ronneby soils, which occur in small depressions, are somewhat poorly drained.

The permeability of this Kingsley soil is moderately slow. The available water capacity is moderate. Surface runoff is rapid. The natural fertility is medium, and the organic matter content is moderate.

Most areas of this soil are used for pasture or woodland. It has fair potential for corn, small grains, and forage crops. It has good potential for woodland. This soil has poor potential for sanitary facilities and fair potential as building sites.

This soil has fair suitability for crops commonly grown in the survey area. The steep slope is the main hazard for production of crops. When farmed, this soil is better suited to small grains or hay than to row crops. The hazard of erosion is severe. No-till planting or using minimum tillage and a high percentage of forage crops reduces erosion. Surface rocks and pebbles impede tillage. Operation of modern farm machinery is difficult on steep slopes.

This soil has fair suitability for pasture and hay. Productivity is fair for all kinds of forage except the wetland species. Proper stocking, rotation grazing, fertilization, and weed control help to keep the pasture and soil in good condition. The use of this soil for pasture or hay is effective in controlling erosion, but care must be taken to prevent overgrazing. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to trees. Plant competition is moderate to severe, however, site preparation and weeding are needed to insure the survival of plantings. Seedling mortality is slight. Equipment limitations and the hazard of erosion are severe. Precautions are needed to keep equipment from tipping on the steeper slopes. To control erosion, this soil should be mulched at time of planting and a protective cover of vegetation must be kept on it.

This soil is suitable as building sites although slope is a severe limitation. Sites for building should be carefully chosen to reduce the amount of excavating and the consequent erosion. Because of its slope and moderately slow permeability, this soil is poorly suited to septic tank absorption fields. To prevent surface seepage, tile lines should follow the contour of the filter field. Lawns, trees, and shrubs are fairly easy to establish. It is recommended that sod be used to reduce the erosion hazard if the lawn is established from grass seed.

This soil is in capability subclass IVe and woodland suitability group 3r.

342E—Kingsley sandy loam, 18 to 30 percent slopes. This steep to very steep soil is well drained. It occurs on narrow side slopes on end moraines. Individual areas are elongated in shape and range from 5 to 20 acres.

Typically, the surface layer is very dark gray sandy loam about 3 inches thick. The subsurface layer is dark grayish brown sandy loam about 3 inches thick. The subsoil is reddish brown sandy loam about 14 inches thick. The underlying material is reddish brown sandy loam. In some areas the original surface layer has been removed by erosion and the present surface layer is reddish brown sandy loam. In places the subsoil and underlying materials are loam. In some small areas slope is less than 18 percent.

Included in mapping are a few small areas of Freeon, Rosholt, and Ronneby soils. The Freeon soils are moderately well drained. They occupy drainageways and the lower, less steep positions on the landscape. The Rosholt soils are well drained and have underlying materials of sand and gravel. The Ronneby soils, which occur in depressions, are somewhat poorly drained.

Permeability of the Kingsley soil is moderately slow. The available water capacity is moderate. Runoff is rapid. The natural fertility is medium, and the organic matter content is moderate.

Most areas of this soil are used for pasture or woodland. This soil has poor potential for crops and fair potential for pasture, hay, and woodland. It has poor potential for sanitary facilities and as building sites.

This soil is too steep to cultivate. Slopes are generally too short and too irregular to make terracing feasible. It is better suited to permanent vegetation than to cultivated crops. Pastures should not be overgrazed because this soil erodes easily if not covered by vegetation. It is hard to renovate and improve, because farm machinery is hard to operate on the steep slopes. In some places gullies on this soil need to be stabilized by engineering structures.

This soil has fair suitability for trees. Seedling mortality is slight on north- and east-facing slopes and moderate on south- and west-facing slopes. Site preparation and weeding are needed to reduce competition from undesired plants. A protective cover of vegetation is needed to prevent erosion. The use of heavy machinery is difficult on the steep slopes.

This soil is poorly suited to sanitary facilities and building site development. Extensive excavating is required

during development, and the danger of erosion is severe. Erosion needs to be controlled during construction. Designing buildings to fit the landscape can preserve the natural landscape and at the same time reduce the need for grading and reduce erosion and sedimentation. This soil is well suited to uses that stress the natural beauty of the area.

Septic tank absorption fields are difficult to construct on the steep slopes, and the hazard of side slope seepage is great. Vegetation is fairly easy to establish. It is recommended that sod be used for establishing lawns because there is an erosion hazard when grass is seeded.

This soil is in capability subclass VIe and woodland suitability group 3r.

367B—Campia silt loam, 0 to 8 percent slopes. This level to moderately sloping soil is well drained. It occupies level and convex areas on glacial lake plains. Delineations are commonly irregular in shape and range from 5 to 30 acres.

Typically, the surface layer is dark grayish brown silt loam about 8 inches thick. The subsurface layer is grayish brown silt loam about 4 inches thick. The next layer is mixed grayish brown and dark brown silt loam about 3 inches thick. The subsoil is dark yellowish brown and dark brown silt loam about 25 inches thick. The underlying material is dark brown and brown, mottled silt loam. In some areas the subsoil contains more sand. In some areas the surface layer is darker colored and thicker or mottles are in the lower part of the subsoil. Slope, in some areas, is more than 8 percent.

Included in some mapped delineations are small areas of Antigo, Santiago, Barronett, Comstock, and Crystal Lake soils. The well drained Antigo soils are underlain by gravelly outwash. The well drained Santiago soils are underlain by loamy glacial till. The poorly drained Barronett soils occupy depressions and drainageways. The poorly drained Comstock soils occupy low areas. The moderately well drained Crystal Lake soils are in the lower positions on the landscape.

The Campia soil is moderately permeable throughout. Available water capacity is high. Surface runoff is medium. Organic matter content is moderate, and natural fertility is medium.

Most areas of this soil are used for crops. Some areas are developed for urban uses. The soil has good potential for cultivated crops, pasture, hay, and woodland. It has fair potential for sanitary facilities and good potential as building sites.

This soil is well suited to most crops grown in the survey area. It warms up fairly early in the spring and can be worked fairly soon after rainfall. If row crops are grown on the steeper slopes, erosion is a severe hazard. The main management needs are maintenance of tilth and control of erosion. Applying manure, growing grasses and legumes, and fertilizing improve soil tilth and fertility. Minimum tillage, winter cover crops, and grassed waterways prevent excessive soil loss. Fall tillage is beneficial because it permits clods to freeze and thaw in winter, producing a spring seedbed of improved tilth.

This soil is well suited to pasture and hay because of its high available water capacity. Pasture and hay planting, weed control, and fertilizer may be necessary to establish desirable plant species. Overgrazing should be avoided because it increases the risk of erosion. If alfalfa is to be planted, either alone or in mixture with other grasses, liming may be necessary.

This soil is well suited to trees. Seedling mortality, equipment limitations, and erosion hazards are slight. Plant competition is severe. Seedlings grow well when competing vegetation is controlled. Site preparation by means of spraying, cutting, girdling, or cultivation are good methods of controlling competing vegetation. There are no limitations or hazards to planting or harvesting trees.

This Campia soil is well suited to most building site development. Soil strength is low, and it is highly susceptible to frost heave. There are moderate changes in the volume of the subsoil with changes in soil moisture. Roads, parking lots, driveways, and large concrete slabs are subject to heaving and cracking unless properly designed. During unusually wet years, seepage occurs on side slopes. Drain tile should be placed around foundation footings to prevent water from seeping into basements. A good tile outlet is needed.

This soil is suited to absorbing septic tank effluent from private homes. It has only fair suitability, however, for sanitary facilities because of the moderate permeability and the firm underlying material. Lawns, trees, and shrubs are generally easy to establish.

This soil is in capability subclass IIe and woodland suitability group 2o.

408—Faxon silt loam. This is a level, poorly and very poorly drained soil. It is in plane or slightly concave positions on rock-cored terraces or structural benches. It formed in glacial drift 20 to 40 inches thick over the bedrock. Individual areas are irregular in shape and 3 to 40 acres in size. This soil is commonly flooded by surface runoff from adjacent areas.

Typically, the surface layer is black silt loam about 7 inches thick. The subsurface layer is black, mottled silt loam about 12 inches thick. The subsoil, about 15 inches thick, is greenish gray, mottled silt loam. Pale brown and very pale brown sandstone bedrock is at a depth of 34 inches. In some areas limestone bedrock underlies the profile.

Included in mapping are small areas of well drained Copaston soils. They occupy higher and/or more sloping terrain. Also included in some areas is a soil that has an organic surface layer up to 30 inches thick over bedrock. The areas are primarily on terraces along the St. Croix River.

Permeability of the Faxon soil is moderate, and the available water capacity is moderate. Surface runoff is

slow or very slow. Natural fertility is medium. The organic matter content is high. A seasonal high water table is at a depth of less than 1 foot. Rooting depth is restricted by the depth to bedrock.

Most areas of this soil are idle grassland or pasture. This soil has poor potential for cultivated crops, pasture, and hay. It has poor potential for sanitary facilities and as building sites. It has fair potential for wetland wildlife habitat.

This soil is poorly suited to cultivated crops because of wetness. Improving drainage is difficult because of the shallow depth to bedrock, but shallow surface ditches can be used to remove excess surface water. Improved permanent pasture is a suitable use for this soil. Pasture should be seeded to adapted grasses and legumes that tolerate wetness. They should not be grazed early in spring or after excessive rainfall, because of the wetness of the surface layer.

This soil is poorly suited to building site development and onsite waste disposal because of the seasonal high water table, the hazard of flooding, and the moderate depth to bedrock. Where this soil must be used as building sites, it must be drained or the foundations must be placed above the water table. This soil is poorly suited to septic tank absorption fields unless special designs are used to overcome the high seasonal water table, the moderate depth to bedrock, and the hazard of flooding. It has fair suitability for wetland wildlife habitat. Some difficulty may be encountered in excavating for ponds because of the depth to bedrock.

This soil is in capability subclass VIw. It is not placed in a woodland suitability group.

411—Waukegan silt loam, 0 to 2 percent slopes. This nearly level soil is well drained. It is on glacial outwash plains, in valley trains, and on stream terraces. Individual areas are irregular in shape and range from 3 to 80 acres.

Typically, the surface layer is very dark brown silt loam about 10 inches thick. The subsoil is about 21 inches thick. The upper part is dark yellowish brown silt loam. The lower part is yellowish brown coarse sand. The underlying material is yellowish brown coarse sand. In places the silty mantle is more than 40 inches thick. In some small areas slope is more than 2 percent.

Included with this soil in mapping are small areas of Chetek, Dickman, and Waukegan Variant soils. The Chetek soils lack the dark colored surface layer of the Waukegan soil. The Dickman soils have a loamy mantle and commonly lack coarse fragments in the underlying material. The Waukegan Variant is underlain by limestone bedrock within a depth of 40 inches.

This Waukegan soil has moderate permeability in the silty mantle and rapid permeability in the underlying material. The available water capacity is moderate. Surface runoff is very slow. Natural fertility is medium, and organic matter content is moderate.

Most areas of this soil are farmed. It has good potential for crops, pasture, and hay. The soil has good potential as building sites and fair potential for most sanitary facilities.

This soil is well suited to corn, soybeans, small grains, and forages. In drier years, it may be droughty because of the low available water capacity of the underlying material. Minimum tillage, crop rotation, and the return of crop residues to the soil improve fertility, increase water infiltration, and increase organic matter content. Crops grown on this soil respond well to a good fertilization program. This soil is well suited to irrigation if a suitable source of water is available.

This soil is well suited to pasture and hay. Productivity is good for all kinds of forage except the wetland species. Proper stocking, rotation grazing, fertilization, and weed control help to keep the pasture and soil in good condition. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to building site development. Sidewalls have poor stability in the underlying material and may cave in during excavation. Temporary retaining walls help to alleviate this problem. Septic tank absorption fields function, but there is a hazard of pollution of underground water supplies and nearby lakes and streams. This hazard can be reduced by using specially designed systems. Trafficability is poor when the upper silty material is wet. Lawns, trees, and shrubs are generally easy to establish and maintain on this soil. This soil is a good source of sand for construction. Consideration should be given to this resource before developing this soil for other uses.

This soil is in capability subclass IIs. It is not placed in a woodland suitability group.

411B—Waukegan silt loam, 2 to 6 percent slopes. This gently sloping soil is well drained. It is on glacial outwash plains, in valley trains, and on stream terraces. Individual areas are irregular in shape and range from 3 to 80 acres.

Typically, the surface layer is very dark gray silt loam about 14 inches thick. The subsoil is dark brown or brown silt loam about 20 inches thick. The underlying material is yellowish brown and light yellowish brown, stratified, medium and coarse sand and fine gravel. In places the silty mantle is more than 40 inches thick.

Included with this soil in mapping are small areas of Chetek, Dickman, and Waukegan Variant soils. The Chetek soils lack the dark colored surface layer of the Waukegan soil. The Dickman soils have a loamy mantle and commonly lack coarse fragments in the underlying material. The Waukegan Variant soils are underlain by limestone bedrock within a depth of 40 inches.

This Waukegan soil has moderate permeability in the silty mantle and rapid permeability in the underlying material. The available water capacity is moderate. Surface runoff is medium. Natural fertility is medium, and organic matter content is moderate.

Most areas of this soil are farmed. The soil has good potential for all the common crops grown in the survey

area. It has good potential as building sites. It has fair potential for most sanitary facilities.

This soil has fair suitability for growing corn, soybeans, small grains, and forages. There is a slight hazard of erosion on the stronger slopes, where stripcropping and mulch tillage should be used. Where slope shape and length permit, contour farming and terracing are effective in controlling erosion. In drier years the soil may be droughty because it has only moderate available water capacity. Minimum tillage, crop rotation, and the return of crop residues to the soil improve fertility, increase water infiltration, and increase organic matter content. Crops grown on this soil respond well to a good fertilization program. This soil is well suited to irrigation if a suitable water source is available.

This soil is well suited to pasture and hay, which are effective means of controlling erosion. Productivity is good for all kinds of forages except the wetland species. Proper stocking, rotation grazing, fertilization, and weed control help to keep the pasture and soil in good condition. Planting pasture and hay may be desirable to improve plant species and potential yield. Overgrazing should be avoided because it increases the risk of erosion.

This soil is well suited to building site development. Sidewalls in the underlying material have poor stability and may cave in during excavation for foundations or utilities. Temporary retaining walls help to reduce this problem. Trafficability is poor when the upper silty material is wet. Erosion needs to be controlled during construction. Septic tank absorption fields function well but there is a hazard of pollution of underground water supplies and nearby lakes and streams. Special designs are needed to reduce this hazard. Lawns, trees, and shrubs are generally easy to establish and maintain on this soil. It is a good source of sand for construction. This resource should be considered before the soil is developed for other uses.

This soil is in capability subclass IIe. It is not placed in a woodland suitability group.

411C—Waukegan silt loam, 6 to 12 percent slopes. This moderately sloping soil is well drained. It occurs on glacial outwash plains, in valley trains, and on stream terraces. Individual areas are irregular in shape and range from 5 to 30 acres.

Typically, the surface layer is very dark grayish brown silt loam about 10 inches thick. The subsoil is about 21 inches thick. The upper part is dark yellowish brown silt loam. The lower part is yellowish brown coarse sand. The underlying material is light yellowish brown coarse sand. In places the surface layer is loam that has a high content of silt.

Included with this soil in mapping are small areas of Chetek, Dickman, and Waukegan Variant soils. The Chetek soils lack the dark colored surface layer of the Waukegan soil. The Dickman soils have a loamy mantle and commonly lack coarse fragments in the underlying material. The Waukegan Variant is underlain by limestone bedrock within a depth of 40 inches.

Permeability of the Waukegan soil is moderate in the silty mantle and rapid in the underlying material. Surface runoff is medium. Natural fertility is medium. Organic matter content and available water capacity are moderate.

Most areas of this soil are farmed. This soil has good potential for small grains and grass and legume hay and pasture. Because erosion is a hazard, potential is only fair for corn and soybeans. It is good for building sites and fair for most sanitary facilities.

This soil has fair suitability for corn, soybeans, small grains, and grass and legume hay and pasture. If the soil is used for cultivated crops, there is a hazard of erosion unless adequate conservation practices are applied to the land. Terraces, diversions, contour cropping, mulch tillage, minimum tillage, and winter cover crops help to prevent excessive soil loss. In many areas slopes are long enough and smooth enough to be terraced or farmed on the contour. Minimum tillage and the regular return of crop residue to the soil improve fertility, increase water infiltration, and increase the content of organic matter.

The use of the soil for pasture or hay is effective in controlling erosion. Proper timing and placement of fertilizer results in optimum growth and minimum contamination of surface and ground water. Proper stocking, rotation grazing, and weed control help to keep the pasture and soil in good condition. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to building site development, although it is limited by slope. As slope increases, the cost of installing utilities and grading for homesites and roads and streets increases. Erosion needs to be controlled during construction. Sidewalls in the underlying material have poor stability and may cave in during excavation or installation of underground utilities. This can be prevented with temporary retaining walls. Septic tank absorption fields function in this soil, but the pollution of underground water supplies and nearby lakes and streams is a possibility. Special design is needed to overcome this hazard. Lawns, trees, and shrubs are generally easy to establish and maintain on this soil. It is a good source of sand for construction.

This soil is in capability subclass IIIe. It is not placed in a woodland suitability group.

449—Crystal Lake silt loam, 1 to 3 percent slopes. This very gently sloping soil is moderately well drained. It occupies plane and convex positions on glacial lake plains and terraces. Delineations are commonly irregular in shape and range from 5 to 30 acres.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is about 29 inches thick. The upper part is brown and yellowish brown silt loam. The lower part is brown, mottled silt loam. The underlying material is dark yellowish brown,

mottled silt loam. In a few areas the underlying material is loamy glacial till. Slope is more than 3 percent in a few places.

Included in some of the mapped areas are small areas of Brill, Barronett, Campia, and Comstock soils. The Brill soils are moderately well drained and are underlain by gravelly outwash. The Barronett soils are poorly drained and occupy slightly concave, lower positions. The Campia soils are well drained and occupy more sloping positions on the landscape. The Comstock soils are somewhat poorly drained and occupy lower, less sloping positions.

This Crystal Lake soil has moderate permeability. The available water capacity is high. Surface runoff is medium. Natural fertility is medium, and organic matter content is low. Depth to the seasonal high water table is commonly 2.5 to 3.5 feet during wet seasons.

Most areas of this soil are used for production of corn, soybeans, small grains, and hay. Many areas are developed for urban uses. This soil has good potential for crops, hay, pasture, and woodland. It has poor potential for sanitary facilities and fair potential as building sites.

This soil is well suited to the agricultural crops common to this area. It warms up fairly early in spring and can be worked soon after rainfall. However, because of low organic matter content and poor natural tilth, the surface layer seals after rains and develops a crust upon drying. This soil is easily eroded by water. The main management needs are maintenance of tilth and control of erosion. Applying manure, growing grasses and legumes, and proper fertilization are ways of maintaining tilth and fertility. Minimum tillage also controls erosion. Fall tillage permits clods to freeze and thaw in winter and produces a spring seedbed of improved tilth.

This soil is well suited to pasture and hay because of its high available water capacity. Pastures and hay can be improved by proper grazing and fertilizing and by seeding suitable grasses and legumes. If alfalfa is planted, either alone or in mixture with grasses, liming may be necessary.

This soil is well suited to trees. Seedling mortality, equipment limitations, and erosion hazard are slight. Plant competition is severe. Seedlings survive and grow well if competing vegetation is controlled or removed, which can be done by site preparation.

This soil has fair suitability as building sites if the wetness is controlled. If this soil is used for houses, drain tile should be installed around basement footings to control the water table. An adequate tile outlet is needed, or foundations need to be placed above the water level. This soil has low strength to support buildings and roads and streets. It is highly susceptible to frost heave. The cost of maintaining streets, sidewalks, parking lots, and utilities may be excessive unless they are designed to withstand frost heaving. This soil is poorly suited to septic tank absorption fields because of the seasonal high water table. Special design is needed to overcome this hazard. Lawns, trees, and shrubs are easy to establish on this soil.

This soil is in capability class I and woodland suitability group 2o.

452—Comstock silt loam. This is a level, somewhat poorly drained soil. It occupies slightly convex or plane positions on glacial lake plains and terraces. Delineations are commonly irregular in shape and range from 3 to 20 acres. The soil may be flooded by surface runoff from adjacent soils after excessive rainfall and when snow melts in spring.

Typically, the surface layer is very dark gray silt loam about 10 inches thick. The subsurface layer is very dark gray silt loam about 9 inches thick. The subsoil is about 33 inches thick. The upper part is dark brown and grayish brown, mottled silt loam. The lower part is brown, mottled silt loam. The underlying material is pale brown, mottled silt loam. In some areas the underlying material is loamy glacial till. Some areas have more sand in the subsoil.

Included in some mapped delineations are small areas of Barronett, Campia, Crystal Lake, Poskin, and Cathro soils. The Barronett soils are poorly drained and occupy slight depressions. The Campia soils are well drained and occupy small elevated areas. The Crystal Lake soils are moderately well drained and occur in slightly higher landscape positions. The Poskin soils are somewhat poorly drained and are underlain by gravelly outwash. The Cathro soils are very poorly drained and have a thick surface mantle of organic soil material.

The Comstock soil has moderate permeability. The available water capacity is high. Surface runoff is slow. The organic matter content is moderate, and natural fertility is medium. The depth to a seasonal high water table is commonly 1 to 3 feet during wet seasons.

Most areas of this soil are used for crops, but some areas are used for pasture. This soil has good potential for cultivated crops, pasture, and hay and fair potential for woodland. It has poor potential for sanitary facilities and as building sites.

Unless artificially drained, this soil is poorly suited to crops. It has poor structure and can be satisfactorily tilled only within a narrow range of moisture content. Applying manure, growing forage crops in rotation, and returning crop residues to the soil help to maintain tilth and fertility. Fall plowing permits clods to be broken by frost action in winter and produces a spring seedbed of improved tilth.

This soil is well suited to pasture because it holds moisture throughout the growing season. Some pastures are partly wooded and brushy, providing poor grazing. They should be cleared and reseeded to adapted grasses and legumes. Grazing in early spring and after heavy rains should be delayed to prevent soil compaction.

This soil has fair suitability for trees. Because the naturally occurring water table is at a depth of 1 to 3 feet during wet periods, adapted species should be planted. Seedling mortality and equipment limitations are slight.

Clearing, spraying, or other site preparation is desirable to eliminate plant competition.

This soil is poorly suited to building site development. If it is used for building, drain tile should be installed around basement footings to prevent water from seeping into basements. Where there is no adequate tile outlet, the foundation needs to be placed above the water table. This soil is highly susceptible to frost action. Streets, roads, and sidewalks may heave unless they are carefully designed and placed on more suitable base material.

This soil is poorly suited to septic tank absorption fields due to the seasonal high water table. Lawns, trees, and shrubs are easy to establish and maintain on this soil.

This soil is in capability subclass IIw and woodland suitability group 2o.

453B—Demontreville loamy fine sand, 2 to 6 percent slopes. This undulating soil is well drained. It occupies convex knolls, slight rises, and plains on ground moraines. Delineations are commonly irregular in shape and range from 3 to 50 acres.

Typically, the surface layer is dark grayish brown loamy fine sand about 7 inches thick. The subsurface layer and upper part of the subsoil are brown loamy fine sand and loamy sand and, combined, they are about 17 inches thick. The lower part of the subsoil is dark reddish brown sandy loam about 17 inches thick. The underlying material is dark reddish brown sandy loam. In some areas the sandy surface mantle is less than 20 inches thick. In other areas the underlying material is loam. The slope in a few areas is more than 6 percent, and in others it may be less than 2 percent.

Included in some mapped delineations are small areas of Mahtomedi, Ronneby, and Rifle soils. The Mahtomedi soils are excessively drained and formed entirely in sandy outwash, unlike the Demontreville soil, which formed in a sandy mantle over loamy glacial till. The Ronneby soils are somewhat poorly drained and occupy wet, low areas. The Rifle soils are very poorly drained and formed entirely in organic soil material. They occupy wet depressions.

This Demontreville soil has rapid permeability in the upper sandy layer and moderately slow permeability in the underlying glacial sediments. Surface runoff is low. Natural fertility, available water capacity, and organic matter content are low.

Most areas of this soil are used for pasture or crops. It has fair potential for crops, pasture, hay, and woodland. It has good potential as building sites and fair potential for sanitary facilities.

This soil has fair suitability for cultivated crops. Because the available water capacity is low, the hazards of drought and soil blowing are the main management concerns. This soil is better suited to early maturing crops, such as small grains, than to corn and soybeans. Unless rainfall is timely, late-maturing crops, such as corn and soybeans, are limited in growth by lack of moisture. This soil is well suited to irrigation. Soil blowing can be reduced by keeping the soil covered with plants over winter. Minimum tillage that keeps the surface rough and trashy also reduces soil blowing.

Using this soil for pasture and hay is very effective in controlling soil erosion. The soil produces fair pasture in spring and early fall, but supplemental pasture may be needed during dry summer months. Proper stocking and pasture rotation help to keep the pasture and soil in good condition. Forage production is fair if adequate moisture is available.

This soil has fair suitability for trees. Seedling mortality is moderate. Plant competition and equipment limitations are slight. The hazard of soil blowing is great. It is necessary to keep the ground covered with sod or to plant windbreaks to keep blowing sand from damaging young seedlings.

This soil is well suited to building site development. There are few limitations. It has fair suitability for sanitary facilities. Special consideration should be given to the sandy mantle when constructing dwellings or septic tank filter fields. Water infiltrates the sandy mantle rapidly and may be temporarily trapped above the loamy underlying material. Drain tile should be installed around foundations to prevent water from seeping into basements. Specially designed septic tank absorption systems are needed to overcome the moderately slow permeability and the hazard of seepage along the contact between the sandy material and the underlying till. Lawns are difficult to establish and maintain on this sandy soil. They should be topdressed with 12 to 18 inches of loamy material that will hold more moisture. Trees and shrubs that are resistant to drought should be planted.

This soil is in capability subclass IIIs and woodland suitability group 3s.

453C—Demontreville loamy fine sand, 6 to 12 percent slopes. This gently rolling soil is well drained. It occupies convex crests and upper side slopes of hills on ground moraines. Mapped areas are irregular in shape and commonly range from 3 to 50 acres.

Typically, the surface layer is very dark gray loamy fine sand about 6 inches thick. The subsoil is about 34 inches thick. The upper part is dark grayish brown and dark brown loamy sand. The lower part is reddish brown sandy loam. The underlying material is reddish brown sandy loam. In some areas the sandy surface mantle is less than 20 inches thick. In other areas the underlying material is loam. The slope in a few areas is less than 6 percent or more than 12 percent.

Included in some mapped delineations are small areas of Mahtomedi, Ronneby, and Rifle soils. The Mahtomedi soils are excessively drained and formed entirely in sandy outwash, whereas the Demontreville soil formed in a sandy mantle over loamy glacial till. The Ronneby soils are somewhat poorly drained and occupy wet, low areas. The Rifle soils are very poorly drained and formed entirely in organic soil material. They occupy wet depressions.

This Demontreville soil has rapid permeability in the upper sandy layers and moderately slow permeability in the underlying glacial sediments. Surface runoff is medium. Natural fertility, available water capacity, and organic matter content are low.

About half the acreage of this soil is cleared and used for pasture, hay, or cultivated crops. The remainder is in woodland. This soil has fair potential for crops, pasture, hay, and woodland. It has fair potential for sanitary facilities and good potential as building sites.

This soil is poorly suited to cultivated crops. Drought is a hazard. Soil blowing and water erosion are also management problems. This soil is better suited to early-maturing crops, such as small grains, than to corn and soybeans. In most years, corn and soybean yields are reduced by lack of moisture. This soil is well suited to irrigation. Returning crop residue to the soil helps improve available water holding capacity and fertility. Slopes are generally too irregular for erosion control practices such as stripcropping or contouring. Soil blowing can be controlled by keeping the soil covered with plants over winter. Minimum tillage that keeps the surface rough and trashy is well suited to this soil and reduces damage caused by both soil blowing and water erosion.

The use of this soil for pasture or hay is effective in controlling soil erosion. Overgrazing should be avoided because the soil erodes easily when left bare. If fertilized, this soil provides fair pasture in spring and early in fall, but supplemental pasture may be needed during dry summer months. Proper stocking, pasture rotation, and timely deferment of grazing will help keep the pasture and soil in good condition. Forage production is fair if adequate moisture is available.

The main limitation for growing trees on this soil is its low water holding capacity. Seedlings may not survive if a dry year follows planting. Plant competition and equipment limitations are slight. The hazards of soil blowing and water erosion are great. Mulching during planting reduces erosion and protects seedlings from damage by blowing sand and water erosion.

This soil is well suited to building site development. Slope is the main limitation. Water infiltrates the sandy mantle rapidly and may be temporarily trapped above the loamy underlying material. Drain tile should be installed around foundations to prevent water from seeping into basements.

This soil has fair suitability for sanitary facilities. Septic tank absorption systems should be specially designed to overcome the moderately slow permeability and the hazard of seepage along the line of contact between the sandy material and the underlying till. Lawns are difficult to establish and maintain on this sandy soil. It should be topdressed with 12 to 18 inches of loamy material before seeding. Drought resistant trees and shrubs should be planted.

This soil is in capability subclass IVe and woodland suitability group 3s.

453D—Demontreville loamy fine sand, 12 to 25 percent slopes. This hilly to steep soil is well drained. It occupies ridges and sides of hills on ground moraines. Delineations are commonly irregular in shape and range from 3 to 50 acres.

Typically, the surface layer is dark grayish brown loamy fine sand about 4 inches thick. The subsurface layer is brown loamy sand about 6 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown loamy sand. The lower part is dark reddish brown sandy loam. The underlying material is dark reddish brown sandy loam. In some areas the sandy surface mantle is less than 20 inches thick. In some areas slope is less than 12 percent or more than 25 percent.

Included in some mapped delineations are small areas of Mahtomedi, Ronneby, and Rifle soils. The Mahtomedi soils are excessively drained and formed entirely in sandy outwash, whereas the Demontreville soil formed in a sandy mantle over loamy glacial till. The Ronneby soils are somewhat poorly drained and occupy wet, low areas. The Rifle soils are very poorly drained and formed entirely in organic soil material. They occupy wet depressions.

This Demontreville soil has rapid permeability in the upper sandy layers and moderately slow permeability in the underlying glacial sediments. Surface runoff is medium. Natural fertility, available water capacity, and organic matter content are low.

Most of this soil is in woodland and pasture. It has fair potential for woodland and fair to poor potential for pasture. It has poor potential for crops. It has poor potential for sanitary facilities and fair potential as building sites.

This soil is poorly suited to crops because of steep slopes, a hazard of erosion, and low available water capacity. Machinery can be difficult and unsafe to operate. If this soil is cropped, minimum tillage or rotations containing forage crops are needed. Droughtiness is a common problem.

The use of this soil for pasture or hay is effective in controlling erosion. It is droughty, and the hazard of erosion is high. Overgrazing of pasture should be prevented because this soil erodes easily when overgrazed. The production of pasture is fair in spring and fall but is low during the dry summer months (fig. 11), at which time supplemental pasture may be needed. Liming and fertilizing are beneficial practices if forages are grown. Planting pasture and hay is generally desirable to establish suitable species and increase potential yield.

This soil has fair suitability for trees. Plant competition is slight. Seedling survival depends on the moisture available to plants and generally is good if a few good rains follow planting. Furrow planting on the contour helps to collect water needed by the planted stock. Equipment limitations and the hazard of erosion are moderate. Care must be taken on the steeper slopes to keep equipment from tipping. Mulching with straw or hay at time of planting helps reduce erosion and protects the new seedlings from soil blowing.

Figure 11.—Area of Demontreville loamy fine sand, 12 to 25 percent slopes. Ronneby soils are in the depressions in the near foreground.

This soil has fair suitability as building sites, although slope is a severe limitation. Extensive grading increases the hazard of erosion and can cause sedimentation. Erosion needs to be controlled during construction. Where slopes are more than 18 percent, this soil is best suited to uses that promote the natural beauty of the area. The use of this soil for septic tank absorption fields is limited by steep slopes. Lawns are difficult to establish and maintain. Drought resistant trees and shrubs should be planted.

This soil is in capability subclass VIe and woodland suitability group 3s.

454B—Mahtomedi loamy sand, 0 to 6 percent slopes. This level to undulating, excessively drained soil is on broad flats, side slopes, and slightly convex crests of glacial moraines and collapsed outwash plains. Mapped areas are irregular in shape and range from 5 to 50 acres.

Typically, the surface layer is dark brown loamy sand about 8 inches thick. The subsoil is about 19 inches thick. The upper part is dark brown gravelly sand. The lower part is reddish brown gravelly coarse sand. The underlying material is stratified reddish brown medium sand and gravelly sand. In some areas the soil is less than 10 percent or more than 35 percent coarse fragments. In small areas the loamy mantle is 12 to 40 inches thick, and in other areas slope is more than 6 percent.

Included with this soil in mapping are small areas of Antigo, Brill, Demontreville, and Kingsley soils. Antigo soils formed in a silty mantle underlain by outwash. Brill soils are moderately well drained and have a silty mantle underlain by outwash. Demontreville soils formed in a sandy mantle underlain by loamy glacial till. Kingsley soils are well drained and formed entirely in loamy glacial till.

Permeability is rapid in this Mahtomedi soil. Surface runoff is slow, and the available water capacity is very low. Organic-matter content and natural fertility are low.

Most areas of this soil are used for crops or pasture. It has fair potential for woodland, pasture, and cultivated crops. It has good potential as building sites and poor potential for sanitary facilities.

This soil has only fair suitability for crops because it has low available water capacity and low natural fertility. Early maturing crops, such as small grains, are preferred because they usually make better use of the spring soil moisture than late maturing crops. Management that increases the organic-matter content will increase the water holding capacity of the soil. Fertilization is needed to offset the low natural fertility. This soil generally is poorly suited to irrigation because it has low available water capacity and is highly susceptible to nutrient loss through leaching.

This soil has only fair suitability for pasture and hay crops, because plant growth is limited by the lack of

water and nutrients. This soil provides fair pasture in the spring and fall, but growth is low during the summer months. If it is used for pasture or hay, proper stocking, fertilization, and weed control are needed to maintain the sod cover. Bromegrass and alfalfa are more resistant to drought and provide more forage than pastures of bluegrass. Liming may be necessary if forage is grown on this soil.

This soil has only fair suitability for trees. Droughtiness is the main limitation. Seedling mortality is moderate. Plant competition and equipment limitations are slight. Diversions or grassed waterways may be needed to divert water from higher slopes and prevent gully erosion. Mulching or windbreaks may be needed in some areas to prevent damage to seedlings from soil blowing.

This soil is well suited to building site development. Foundations are relatively easy to excavate, but sidewalls have poor stability and may cave in during excavation or when underground utilities are installed. This can be prevented by using temporary retaining walls. Septic tank absorption fields function well, but there is a hazard of pollution of underground water supplies and nearby lakes and streams. Specially designed absorption systems are needed to overcome this hazard. Lawns, trees, and shrubs are difficult to establish on this soil and require frequent watering and fertilization. This soil is a good source of sand for construction purposes. This resource might be developed before other uses of this soil are considered.

This soil is in capability subclass IVs and woodland suitability group 3s.

454C—Mahtomedi loamy sand, 6 to 12 percent slopes. This gently rolling soil is excessively drained. It is on convex tops and sides of ridges on glacial moraines and outwash plains. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is dark yellowish brown loamy sand about 8 inches thick. The subsoil is about 30 inches thick. The upper part is reddish brown coarse sand. The lower part is reddish brown gravelly coarse sand. The underlying material is light reddish brown gravelly sand. In some areas the underlying material is less than 10 percent or more than 35 percent coarse fragments. In some areas the soil has a loamy mantle, 12 to 40 inches thick, over stratified sands and gravel. In small areas slope is less than 6 percent or more than 12 percent.

Included with this soil in mapping are small areas of Antigo, Brill, Demontreville, and Kingsley soils. Antigo soils are well drained and have a thick silty surface layer. Brill soils are moderately well drained and also have a thick silty surface layer. Demontreville soils are well drained and formed in sandy outwash underlain by loamy glacial till. Kingsley soils are well drained and formed entirely in loamy glacial till.

This Mahtomedi soil has rapid permeability. Surface runoff is medium, and the available water capacity is very low. Organic-matter content and natural fertility are low.

Most areas of this soil are used for crops or pasture. It has fair potential for trees and pasture but poor potential for cultivated crops. It has good potential for building site development and poor potential for most sanitary facilities.

This soil is poorly suited to cultivated crops because it has very low available water capacity and low natural fertility and the hazard of erosion is severe. Early-maturing crops, such as small grains, should be planted because they usually make better use of the spring soil moisture than late-maturing crops. Fertilization is needed to offset the low natural fertility. Erosion needs to be controlled. Minimum tillage, no-till planting, and cover crops help to maintain the level of organic matter, conserve moisture, and reduce erosion. This soil is poorly suited to irrigation because it has very low available water capacity and is highly susceptible to nutrient loss through leaching.

This soil has only fair suitability for pasture and hay crops, because plant growth is limited by low available water capacity and low fertility. Fertilization is needed to overcome the low fertility. This soil provides fair pasture in the spring and fall, but production is very low during the summer months and supplemental pasture may be needed. The use of this soil for pasture or hay crops is effective in controlling erosion. It is important to prevent overgrazing because this soil erodes easily if overgrazed. Pasture and hayland may need to be planted to drought resistant forage species.

This soil has only fair suitability for woodland. Seedling mortality is moderate because of droughtiness and wind erosion, but seedling survival is good if a few good rains follow planting. Furrow planting helps to collect water needed by the planted stock. Mulching or establishing windbreaks may be necessary to prevent damage to seedlings from soil blowing. Diversions or grassed waterways may be needed to divert water from higher slopes and prevent gully erosion. Plant competition and equipment limitations are slight.

This soil is well suited to building site development. Slope is the main limitation. Because this soil is noncohesive, gullies can easily develop from the increased runoff from roofs and streets. Erosion needs to be controlled during construction. Foundations are relatively easy to excavate, but sidewalls have poor stability and may cave in during excavation or installing of underground utilities. This can be prevented by using temporary retaining walls. Septic tank absorption fields function well, but there is a hazard of pollution of underground water supplies and nearby lakes and streams unless systems are specially designed. Lawns, trees, and shrubs are difficult to establish on this soil and require frequent watering and fertilization. This soil is a good source of sand for construction purposes.

This soil is in capability subclass IVs and woodland suitability group 3s.

454D—Mahtomedi loamy sand, 12 to 25 percent slopes. This hilly to steep soil is excessively drained. It formed in gravelly sand glacial outwash on glacial moraines and collapsed outwash plains. Individual areas are irregular in shape and range from 10 to 60 acres.

Typically, the surface layer is very dark loamy sand about 5 inches thick. The subsurface layer, about 3 inches thick, is brown sand. The subsoil is about 22 inches thick. The upper part is dark brown gravelly coarse sand. The lower part is reddish brown gravelly sand. The underlying material is stratified reddish brown and light reddish brown gravelly sand. In some areas the underlying material is less than 10 or more than 35 percent coarse fragments. In small areas the soil has a loamy mantle 12 to 40 inches thick. In other small areas slope is less than 12 percent or more than 25 percent.

Included with this soil in mapping are small areas of Antigo, Demontreville, and Kingsley soils, all of which are well drained. Antigo soils have a thick silty surface layer. Demontreville soils formed in sandy outwash underlain by loamy glacial till. Kingsley soils formed entirely in loamy glacial till.

Permeability is rapid in the Mahtomedi soil. The available water capacity is very low, and surface runoff is rapid and very rapid. Organic-matter content and natural fertility are both low.

Most areas of this soil are in pasture and woodland. This soil has poor potential for cultivated crops but fair potential for pasture and woodland. Potential is poor for sanitary facilities and fair for building site development.

This soil is generally not used for cultivated crops because it has very low available water capacity and low natural fertility and the hazard of erosion is severe. Early-maturing crops, such as small grains, should be planted because they usually make better use of the spring soil moisture than late-maturing crops. A fertilization program is needed to offset the low natural fertility. There is a severe hazard of erosion unless conservation management is used. Minimum tillage, no-till planting, and cover crops help maintain the level of organic matter, conserve moisture, and reduce erosion.

This soil has only fair suitability for pasture and hay crops because plant growth is limited by low available water capacity and low fertility. Fertilization is needed to overcome the low natural fertility. This soil provides fair pasture in the spring and fall, but production is very low during the summer months. Supplemental pasture may be needed at this time. The use of this soil for pasture or hay is effective in controlling erosion. It is important to prevent overgrazing, because this soil erodes easily when overgrazed.

This soil has fair suitability for trees. The hazards of seedling mortality and erosion are moderate. Seedling survival is dependent on available moisture. Furrow planting helps to collect water needed by the planted stock. Mulching at time of planting helps prevent damage to seedlings by soil blowing. Grassed waterways or diversions may be needed to divert water from higher slopes and prevent gully erosion. Plant competition is slight, and equipment limitations are moderate. Care must be taken to keep equipment from tipping on the steeper slopes. Some equipment may have limited use in summer because this soil is loose and sandy.

This soil has only fair suitability for building development. Slope is a severe limitation for most uses. Foundations are relatively easy to excavate, but sidewalls have poor stability and may cave in during excavation or installing of underground utilities. This can be prevented by using temporary retaining walls. Erosion needs to be controlled during construction. Because this soil is noncohesive, it gullies easily. Increased runoff from roofs and streets can cause severe erosion. This soil is poorly suited to septic tank absorption fields because it has steep slopes and there is a hazard of pollution of nearby streams, lakes, and water supplies. Vegetation is difficult to establish and maintain on this soil because of the steep slopes and droughtiness. Once established, it requires frequent watering and fertilization. This soil is a good source of sand for construction purposes.

This soil is in capability subclass VIs and woodland suitability group 3s.

454F—Mahtomedi loamy sand, 25 to 40 percent slopes. This very steep soil is excessively drained. It occupies escarpments, convex ridgetops, and short slopes on hillsides in areas of glacial drift. Individual areas are irregular in shape and range from about 5 to 40 acres.

Typically, the surface layer is very dark gray loamy sand about 3 inches thick. The subsoil, about 20 inches thick, is dark brown loamy sand. The underlying material is brown stratified medium sand and gravelly coarse sand. The soil in some areas is less than 10 percent or more than 35 percent coarse fragments. In small areas slopes are less than 25 percent or more than 40 percent. In other small areas the soil has a loamy mantle 12 to 20 inches thick.

Included with this soil in mapping are small areas of Demontreville and Kingsley soils. The Demontreville soils formed in a sandy mantle underlain by loamy glacial till, and the Kingsley soils formed entirely in loamy glacial till.

This Mahtomedi soil has rapid permeability. Surface runoff is very rapid, and the available water capacity is very low. Organic matter content and natural fertility are low.

This soil is mainly used as woodland. It has fair potential for trees. It has poor potential for cultivated crops, pasture, and small grains. Potential is also poor for sanitary facilities and development of building sites.

Because of the steepness of slope and the hazards of erosion and drought, this soil is not suited to cultivated crops. Because slopes are not only very steep, but commonly very short and irregular, machinery is very difficult and unsafe to operate.

This soil is poorly suited to pasture. Keeping a continuous plant cover reduces erosion, however. If the soil is

pastured, a system of rotation grazing is desirable, and warm-season grasses should be seeded to insure adequate production during dry summer months. Supplemental pastures may be needed at this time. It is essential that overgrazing be prevented, because this soil erodes easily when overgrazed.

This soil has only fair suitability for trees. Seedling mortality is severe because the available water capacity is very low. Furrow planting helps to collect water needed by the planted stock. Plant competition is slight. Equipment limitations are moderate to severe because of the steepness of slope. Care must be taken to keep equipment from tipping. Because the hazard of erosion is moderate to severe, care must be taken to prevent excessive soil loss. Installing grass waterways or diversions to direct water across the slopes and stabilizing existing gullies are methods of controlling erosion.

This soil is poorly suited to sanitary facilities and building site development because of the steepness of the slope. Extensive grading increases erosion and can cause sedimentation in nearby lakes and streams. Care must be taken to control erosion during construction. If this soil is used for building sites, buildings should be designed to fit the site—to preserve the natural landscape and at the same time reduce erosion, sedimentation, and the amount of grading required. This soil has poor suitability for septic tank absorption fields because of the very steep slopes. Downslope seepage of effluent is a hazard, and filter fields are difficult to lay out. In addition, the pollution of ground water supplies is a hazard. This soil is a good source of sand for construction purposes. Lawns, shrubs, and trees are difficult to establish and maintain on this soil because of steepness of slope and droughtiness. When plants are established, they require frequent watering and fertilization.

This soil is in capability subclass VIIs and woodland suitability group 3s.

456—Barronett silt loam. This is a level, poorly drained soil. It occupies slightly concave depressions and broad, low lying flats on terraces and glacial lake plains. Delineations are commonly irregular in shape and range from 5 to 20 acres. Surface runoff from adjacent soils commonly floods this soil for short periods in spring and after heavy rainfalls.

Typically, the surface layer is black silt loam about 7 inches thick. The subsurface is very dark gray silt loam about 5 inches thick. The subsoil is about 27 inches thick. The upper part is dark grayish brown, friable silty clay loam. The lower part is multicolored, friable silt loam. The underlying material is mixed light brownish gray and light yellowish brown, mottled silt loam. In some areas stratified sand and gravel underlie this soil at a depth of 40 to 60 inches.

Included in some mapped delineations are small areas of Grays and Cathro soils. The Grays soils are moderately well drained and occupy small elevated areas. The Cathro soils are very poorly drained and have a thick surface mantle of organic soil material.

The Barronett soil has moderately slow permeability. The available water capacity is very high, and the organic matter content is high. Natural fertility is medium. This soil has a high corrosion potential for uncoated steel. A seasonal high water table is at a depth of less than 1 foot during wet seasons.

Most areas of this soil are used for crops, but some remain in woodland. This soil has fair potential for cultivated crops, hay, and pasture. It has poor potential for woodland. It has poor potential as building sites and for sanitary facilities.

Drainage is needed for cultivated crops. However, in many instances adequate tile outlets are lacking. After drainage the rooting zone is deep. Crop response is good to fertilizer and lime. Working this soil when wet can cause compaction of the surface layer, thereby reducing infiltration of air and water.

If adequately drained, this soil is suitable for pasture and hay. Grazing when the soil is too wet will cause surface compaction and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep pasture and soil in good condition.

This soil is poorly suited to trees. Seedling mortality, equipment limitations, and plant competition are severe concerns to management. The high seasonal water table is the major limiting factor.

This soil has poor potential for building site development and for sanitary facilities because of flooding and wetness. If this soil is used for building, drainage is needed or foundations should be placed above the water table. Unless properly designed, the maintenance and upkeep of parking lots, roads, and utilities can be expensive due to structural damage by frost action. Conventional septic tank absorption fields do not function properly because of the high seasonal water table, flooding, and the moderately slow permeability of this soil. Sod, trees, and shrubs are easy to establish.

This soil is in capability subclass IIw and woodland suitability group 5w.

460B—Baytown silt loam, 1 to 6 percent slopes. This very gently sloping to gently sloping soil is well drained. It occupies plane or convex areas of loess mantled, bedrock controlled uplands. It formed mainly in 20 to 40 inches of silty and loamy sediment over the bedrock. Delineations are irregular in shape and cover 3 to 30 acres.

Typically, the surface soil is very dark gray silt loam about 11 inches thick. The subsurface layer is very dark gray and very dark grayish brown silt loam about 8 inches thick. The subsoil is about 17 inches thick. The upper part is dark brown silt loam. The middle part is dark yellowish brown loam. The lower part is yellowish brown loamy sand. Light gray to yellow, weakly indurated sandstone bedrock is at a depth of 36 inches. Slope in some areas may be more than 6 percent.

Included in some of the mapped delineations are small areas of Ostrander, Waukegan, Lindstrom, and Gale

soils. Ostrander soils have a silty mantle and are underlain by yellowish brown loamy till. Waukegan soils are silt mantled and are underlain by yellowish brown sand and gravel. Lindstrom soils formed primarily in recent colluvium and occupy drainageways or low areas. The Gale soils are well drained. They are in similar landscape positions to the Baytown soil but have a lighter colored surface layer. Some of the lower, less sloping areas are moderately well drained.

This Baytown soil has moderate permeability in the silty mantle and rapid permeability in the sandstone residuum. Available water capacity is moderate. Surface runoff is medium. The organic matter content is moderate, and natural fertility is medium.

Most areas of this soil are used for crops. Other areas are used for pasture or hay. This soil has good potential for small grains and grass and legume hay and pasture. It has fair potential for corn and soybeans. It has good potential as building sites and poor potential for sanitary facilities.

This soil is well suited to small grains and grass and legume hay and pasture. It has fair suitability for corn and soybeans. If the soil is used for cultivated crops, the hazard of erosion needs to be controlled. Where slope permits, terracing or contour farming are adequate protection. However, if areas are too small in extent, too irregular in shape, or too short of slope, minimum tillage and forage crops in a rotation provide better protection from erosion. Droughtiness may be a problem due to the moderate available water capacity.

This soil is well suited to pasture and hay production. Proper stocking, weed control, fertilizing, and rotation grazing help to keep the pasture and soil in good condition. Pastures of bromegrass and alfalfa produce more forage than pastures of bluegrass. Overgrazing should be avoided because it increases the risk of erosion. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to building site development. The moderate depth to rock is the main limitation. Excavating and grading are generally not difficult because slopes are gentle and the material is workable. Foundations generally are easy to excavate because the sandstone bedrock is rippable by backhoes. However, indurated layers are in some areas. Susceptibility to frost action is high and needs to be considered in the design of roads and streets. Septic tank absorption fields function in this soil. There is, however, a severe hazard of pollution of the ground water unless specially designed systems are installed. Lawns, trees, and shrubs are generally easy to establish and maintain on this soil.

This soil is in capability subclass IIe. It is not placed in a woodland suitability group.

460C—Baytown silt loam, 6 to 12 percent slopes. This moderately sloping soil is well drained. It occurs on plane or convex side slopes in areas of loess mantled, bedrock controlled uplands. It formed mainly in 20 to 40 inches of silty and loamy sediment over the bedrock. Delineations are irregular in shape and cover 3 to 30 acres.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is about 26 inches thick. The upper part is dark yellowish brown silt loam. The lower part is dark yellowish brown sandy loam. The underlying material is weakly cemented yellow sandstone. In some areas it may be reddish or white sandstone. Areas with slopes of less than 6 percent or more than 12 percent are in some delineations.

Included in some of the mapped delineations are small areas of Ostrander, Gale, and Copaston soils. Ostrander soils have a silty mantle and are underlain by yellowish brown loamy till. Gale soils have a silty mantle over sandstone, but lack the thick, dark colored surface layer of the Baytown soil. Copaston soils have a shallow loamy mantle over sandstone. Some soils in lower, less sloping positions are moderately well drained.

This Baytown soil has moderate permeability in the silty mantle and rapid permeability in the sandstone residuum. The available water capacity is moderate. Surface runoff is rapid. The organic matter content is moderate, and natural fertility is medium. This soil has high potential for concrete.

Most areas of this soil are used for crops. Other areas are used for pasture or hay. This soil has poor potential for row crops and good potential for small grains and grass and legume hay and pasture. It has good potential as building sites and poor potential for sanitary facilities.

This soil is commonly cropped with the surrounding soils and is suited to small grains and grass hay or pasture. If it is used for cultivated crops, there is a severe hazard of erosion. As slope increases, more effective methods of erosion control must be used. Stripcropping and contour farming should be employed where slope length and shape permit. In other places minimum tillage or forage crops in the rotation are acceptable methods of erosion control. Applying manure, growing grasses and legumes, and proper fertilization control erosion and improve tilth and fertility.

This soil is well suited to pasture and hay production. It requires periodic application of nutrients and rotational grazing to sustain satisfactory growth of pasture plants. Ordinarily, neither permanent pasture nor rotation pasture provides adequate forage in dry periods. Hayland management requires weed control, fertilizing, and timely harvesting.

This soil is well suited to building site development. The moderate depth to rock and the slope are the main limitations. Foundations generally are easy to excavate because the sandstone bedrock is rippable by backhoes. However, indurated layers are in some areas. Susceptibility to frost action is high and needs to be considered in the design of roads and streets. Septic tank absorption fields function in this soil; however, there is a severe hazard of pollution of ground water unless specially designed systems are installed. Lawns, trees, and shrubs

are generally easy to establish and maintain on this soil. During revegetation a soil cover should be used for erosion control.

This soil is in capability subclass IIIe. It is not placed in a woodland suitability group.

468—Otter silt loam. This is a level, poorly drained soil in upland drainageways. Individual areas range from 10 to 100 acres and are irregular in shape. This soil is subject to frequent flooding by runoff from adjacent steeper soils.

Typically, the surface layer is black silt loam about 9 inches thick. The subsurface layer is black silt loam about 29 inches thick. The underlying material is black, mottled silt loam.

Included in mapping are small areas of Cathro and Lindstrom soils. The Cathro soils are very poorly drained and consist of fibrous peat to a depth of about 35 inches. The Lindstrom soils are well drained and are at the upper ends of some drainageways. Included in some areas are soils that are underlain by gravelly coarse sand within a depth of 40 to 60 inches.

Permeability of this Otter soil is moderate. Surface runoff is very slow to ponded. The available water capacity is high. Natural fertility is medium, and the organic matter content is high. A seasonal high water table is less than 2 feet below the surface.

Most areas of this soil are cropped. It has fair potential for cultivated crops and good potential for pasture. It has poor potential for sanitary facilities and as building sites.

Unless artificially drained, this soil is poorly suited to growing crops. It warms slowly in the spring and dries slowly after rains. Water stands on the surface for short periods. When properly drained and managed, this soil is productive. Drainage systems are needed to remove surface water and to lower the water table and permit proper root development.

Some undrained areas of this soil are in permanent pasture. This soil is well suited to pasture because it holds moisture throughout the growing season. Grazing should be delayed in early spring and after heavy rains to prevent damage to the pasture as a result of soil compaction. Proper stocking, rotation grazing, weed control, and fertilization are good management practices.

Because of wetness and the hazard of flooding, this soil is poorly suited to building site development. Susceptibility to frost action is high, and soil strength is low. Streets, roads, and sidewalks tend to heave and crack if not carefully constructed. This soil is poorly suited to septic tank absorption fields because of the seasonal high water table and hazard of flooding. Sod, trees, and shrubs are easy to establish.

This soil is in capability subclass IIw. It is not placed in a woodland suitability group.

472B—Channahon silt loam, 1 to 6 percent slopes. This very gently sloping to gently sloping soil is well drained. It formed in 10 to 20 inches of loess over limestone bedrock on uplands and terraces. Individual areas are irregular in shape and range from 3 to 15 acres.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is dark brown and brown silt loam about 10 inches thick. Limestone bedrock is at a depth of 18 inches. In some areas a thin layer of residuum of limestone occurs between the silty mantle and limestone bedrock. Small areas with slope of more than 6 percent are in some delineations.

Included with this soil in mapping are small areas of Ripon soils in which the silty mantle is more than 20 inches thick over limestone bedrock. Outcrops of limestone bedrock are in some delineations.

This Channahon soil has moderate permeability. Surface runoff is slow. The available water capacity is low because the soil is shallow. Natural fertility is medium, and the organic matter content is moderate.

Some areas of this soil are farmed but many are in pasture, hay, or woodland. This soil has poor potential for cultivated crops because it is shallow. It has fair potential for small grains, hay, pasture, and woodland. It has poor potential for sanitary facilities and as building sites.

This soil is poorly suited to row crops. It has fair suitability for small grains. The rooting zone and available water capacity are restricted by the shallowness to the underlying bedrock. This soil is droughty during most summers. Erosion is a slight problem on the steeper slopes where minimum tillage should be used.

This soil has fair suitability for permanent pasture or hay. It provides good pasture in spring or fall and fair to poor pasture in summer because the available water capacity is low. Proper stocking, rotation grazing, fertilization, and weed control help to keep the pasture and soil in good condition. The use of this soil for pasture or hay is also effective in controlling erosion.

This soil is well suited to trees, but the shallow rooting zone and low available water capacity make selective planting necessary. The hazards of seedling mortality and plant competition are slight.

This soil is poorly suited to sanitary facilities and building site development. In places the underlying bedrock is very hard or cemented, and large machinery is required for excavation. Frost heave and changes in soil moisture result in moderate changes in soil volume and need to be considered in the design of roads and streets. This soil is poorly suited to residential development with onsite sewage disposal systems because bedrock is at a shallow depth. Also, there is a hazard of pollution of ground water by effluent seeping through the fissures and cracks in the bedrock unless specially designed systems are installed. Grasses, trees, and shrubs are generally easy to establish. It may be desirable to topdress this soil with 12 to 18 inches of loamy material to provide a deeper rooting zone for plants. Additional watering may be necessary during dry periods.

This soil is in capability subclass IIIe and woodland suitability group 3d.

472C—Channahon silt loam, 6 to 12 percent slopes. This moderately sloping soil is well drained. It formed in 12 to 20 inches of loess over limestone bedrock on uplands and terraces. Individual areas are irregular in shape and range from 3 to 15 acres.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is dark brown silt loam about 10 inches thick. The soil is underlain by limestone bedrock. In some areas a thin layer of residuum occurs between the silty mantle and the limestone bedrock. Small areas with slope of less than 6 percent or more than 10 percent are in some delineations.

Included with this soil in mapping are small areas of Ripon soils in which the silty mantle is more than 20 inches thick over limestone bedrock. Outcrops of limestone bedrock are in some delineations.

This Channahon soil has moderate permeability. Surface runoff is medium. The available water capacity is low because the soil is shallow. Natural fertility is medium, and organic matter content is moderate.

Some areas of this soil are farmed, but many are in pasture, hay, or woodland. This soil has poor potential for cultivated crops because it is shallow. It has fair potential for pasture, hay, and woodland. It has poor potential for sanitary facilities and as building sites.

This soil is poorly suited to row crops but is better suited to small grains. The rooting zone and available water capacity are restricted by the shallowness to the underlying bedrock. This soil is subject to droughtiness during most summers. Erosion is a problem. Cultivation up and down slopes should be avoided and conservation practices such as minimum tillage or using forage crops in the crop rotation should be used.

This soil has fair suitability for permanent pasture or hay. Production of pasture is good in spring and fall and fair to poor in summer because of the low available water capacity. Proper stocking, rotation grazing, fertilization, and weed control help to keep the pasture and soil in good condition. The use of this soil for pasture or hay is also effective in controlling erosion.

This soil has fair suitability for trees, but the shallow rooting zone and low available water capacity make selective planting necessary. The hazards of seedling mortality and plant competition are slight.

This soil is poorly suited to sanitary facilities and building site development. In most areas the underlying bedrock is very hard or cemented, and large machinery is required for excavation. Erosion needs to be controlled during construction. Frost heave and changes in soil moisture cause moderate changes in soil volume that need to be considered in designing roads and streets.

This soil is poorly suited to septic tank absorption fields because it is shallow to bedrock. Special designs are needed if it is used for this purpose. Lawns, trees, and shrubs are generally easy to establish but may need additional watering during dry periods. It may be desirable to topdress the soil with 12 to 18 inches of loamy material to provide a deeper rooting zone for plants.

This soil is in capability subclass IVe and woodland suitability group 3d.

472D—Channahon silt loam, 12 to 18 percent slopes. This moderately steep soil is well drained. It formed in 12 to 20 inches of loess over limestone bedrock on uplands and terraces. Individual areas are irregular in shape and range from 3 to 15 acres.

Typically, the surface layer is black silt loam about 8 inches thick. The subsoil is dark brown and dark yellowish brown loam about 8 inches thick. The soil is underlain by limestone bedrock. In some areas a thin layer of residuum occurs between the silty mantle and the limestone bedrock. Small areas with slope of less than 12 percent or more than 18 percent are in some delineations.

Included with this soil in mapping are small areas of Ripon soils that have a silty mantle more than 20 inches thick over limestone bedrock. Outcrops of limestone bedrock are in some delineations.

This Channahon soil has moderate permeability. Surface runoff is rapid. The available water capacity is low because the soil is shallow. Natural fertility is medium, and organic matter content is moderate.

Most areas of this soil are in pasture, hay, or woodland. This soil has poor potential for cultivated crops. It has fair potential for pasture, hay, and woodland. It has poor potential for sanitary facilities and as building sites.

This soil is poorly suited to row crops or small grains because of the erosion hazard and shallow rooting depth. It is also subject to droughtiness during most summers because of the low available water capacity.

This soil has fair suitability as long-term hayland or permanent pasture. It provides good pasture in the spring and fall, and fair to poor pasture in summer because of its low available water capacity. Proper stocking, rotation grazing, fertilization, and weed control help to keep the pasture and soil in good condition. The use of this soil for pasture or hay is also effective in controlling erosion.

This soil has fair suitability for trees, but the shallow rooting zone and low available water capacity make selective planting necessary. Use of some large equipment may be limited on the steeper slopes. Care must be taken to prevent erosion during planting or harvesting.

This soil is poorly suited to sanitary facilities and building site development. In most areas the underlying bedrock is very hard or cemented and large machinery is required for excavation. Erosion needs to be controlled during construction. Frost heave and changes in soil moisture cause moderate changes in soil volume and need to be considered in the design of roads and streets.

This soil is poorly suited to septic tank absorption fields because of shallowness to bedrock and steep slopes. Special designs are needed if it is used for this purpose. Lawns, trees, and shrubs are generally easy to establish but may need additional watering during dry

periods. It may be desirable to topdress this soil with 12 to 18 inches of loamy material to provide a deeper rooting zone for plants.

This soil is in capability subclass VIe and woodland suitability group 3d.

481—Kratka fine sandy loam. This is a level, poorly drained soil. It occurs on low flats and in drainageways and shallow depressions. Delineations are commonly 3 to 15 acres. Surface runoff from adjacent soils frequently floods this soil for brief periods early in spring.

Typically, the surface layer is black fine sandy loam about 11 inches thick. The subsurface layer, about 3 inches thick, is very dark gray, mottled loamy fine sand. The subsoil, about 15 inches thick, is light brownish gray, mottled fine sand. The underlying material is olive gray and gray, mottled fine sandy loam and sandy clay loam.

Included with this soil in mapping are small areas of Blomford, Braham, Markey, and Webster soils. The Blomford soils are somewhat poorly drained and formed in a sandy mantle over fine sandy loam till. The Braham soils are well drained and occupy higher rises in the landscape. The Markey soils are very poorly drained and formed in muck underlain by fine sand. The Webster soils are poorly drained. They have a loamy surface layer underlain by fine sandy loam till.

Permeability of the Kratka soil is rapid and moderately rapid in the upper sandy layers and moderately slow in the underlying loamy material. The available water capacity is moderate. Natural fertility is medium, and organic matter content is low. A seasonal high water table is commonly within 3 feet of the surface.

Some areas of this soil are drained and used for crops. Other areas are idle, in permanent pasture, or used for wildlife habitat. This soil has fair potential for cultivated crops, hay, and pasture when drained. It has good potential for wetland wildlife habitat. It has poor potential for sanitary facilities and as building sites.

If properly drained and managed, this soil has fair suitability for all the crops grown in the survey area. It is generally used for corn and soybeans. Unless drained, this soil warms slowly in spring and dries slowly after rains. Because it is sandy, however, it can be tilled over a wide range of moisture content. During the dry summer months when the water table is deep, crop growth may be limited by lack of moisture. The water table must be controlled for best crop production.

If adequately drained, this soil is suited to pasture. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep pasture and soil in good condition. Planting pasture may be desirable to improve plant species and potential yield.

This soil is well suited to wetland wildlife habitat. Ponds may need to be sealed to prevent loss of water through seepage. Wetland food and cover plants can be expected to grow well.

This soil is poorly suited to sanitary facilities and building site development because of wetness and flooding. Basements may be wet unless the water table is lowered or foundations are placed above the water table. Volume changes with changes in soil moisture are low in the sandy mantle and moderate in the underlying loamy material. Soil strength is low and needs to be considered in the design of roads and streets. The hazard of frost heave is moderate. Foundations and trenches for utilities are relatively easy to excavate; however, sidewalls have poor stability and may cave in. This can be prevented with temporary retaining walls. This soil is poorly suited to septic tank absorption fields because of the flooding, the seasonal high water table, and the moderately slow permeability. Lawns, trees, and shrubs are difficult to establish on this soil.

This soil is in capability subclass IIw. It is not placed in a woodland suitability group.

488F—Brodale flaggy loam, 20 to 50 percent slopes. This steep and very steep soil is excessively drained. It is on middle and upper parts of valley sides in dissected terrain. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is very dark gray flaggy loam about 7 inches thick. The subsoil is dark brown flaggy very fine sandy loam about 6 inches thick. The underlying material is brown flaggy very fine sandy loam about 37 inches thick. Bedded limestone bedrock is at a depth of 50 inches. In some areas where soils have developed under woodland vegetation, the surface layer has lighter colors. In some areas there is not a flaggy surface layer.

Included with this soil in mapping are small areas where the lower slopes are underlain by sandstone bedrock. Small areas of bedrock outcrops are in some delineations.

Permeability of this Brodale soil is moderate. Natural fertility, organic matter content, and available water capacity are low. The depth to bedrock is 40 to 60 inches.

Most areas of this soil are left idle or are used for pasture. It has poor potential for cultivated crops, hay, and pasture. It also has poor potential for building site development and sanitary facilities.

This soil is poorly suited to row crops or small grains because the available water capacity is low and working with machinery on the steep slopes is hazardous. Droughtiness is a hazard because of the numerous flagstones throughout the profile. This soil produces poor pasture and hay because it is droughty and has numerous stones on the surface.

Because it has steep slopes, this soil is poorly suited to building site development and sanitary facilities. If it is used for building, designing buildings to fit the site can preserve the natural landscape and at the same time reduce the need for grading and control erosion and sedimentation. In most areas the underlying bedrock is very hard and large machinery is required for excavation, thereby increasing construction costs. This soil is poorly suited to septic tank absorption fields because of steep slopes.

This soil is in capability subclass VIIs. It is not placed in a woodland suitability group.

504B—Duluth silt loam, 1 to 6 percent slopes. This very gently undulating to undulating soil is well drained. It occupies hills, ridges, and knolls on pitted ground moraines. Delineations are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is dark yellowish brown silt loam about 9 inches thick. The subsoil is about 41 inches thick. The upper part is reddish brown loam. The lower part is dark reddish brown loam. The underlying material is reddish brown loam. In a few areas the dominant texture of the profile is sandy loam. In other areas the upper 10 to 30 inches is sandy or silty. Slopes are more than 6 percent in some areas.

Included in some mapped delineations are small areas of Ronneby, Mahtomedi, and Rifle soils. The Ronneby soils are somewhat poorly drained and occupy wet, low areas. The Mahtomedi soils are excessively drained and formed in glacial outwash, whereas the Duluth soil formed in loamy glacial till. The Rifle soils are very poorly drained and formed entirely in organic soil material. They occupy wet depressions. Some of the lower, less sloping areas are moderately well drained.

Permeability of the Duluth soil is slow. Surface runoff is medium. The available water capacity is high. Natural fertility and organic matter content are low. The surface layer is friable and easily tilled.

Most areas of this soil are in crops. This soil has good potential for cultivated crops, small grains, pasture, hay, and woodland. It has fair potential as building sites and for most sanitary facilities.

This soil is well suited to all crops commonly grown in the survey area. It warms slowly in spring and dries slowly after rains. If well managed it is well suited to corn, soybeans, small grains, and hay. The main management problems are control of erosion, low natural fertility, and low organic matter content. Erosion can be reduced by incorporating plant residue into the soil or by minimum tillage. Crops grown on this soil respond well to applications of fertilizer and lime. Use of green manure crops and returning crop residue to the soil help to increase the organic matter content. Minimum tillage that leaves the surface rough and trashy is effective in controlling erosion.

This soil is well suited to pasture. Overgrazing or grazing when the soil is too wet will cause surface compaction and increase surface runoff. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to trees. Seedling mortality is slight. Plant competition is moderate. Some control of competing weeds and shrubs is necessary. Equipment limitations and erosion hazard are slight.

This soil has fair suitability for building site development. It has moderate volume changes with changes in soil moisture and is moderately susceptible to frost action. Streets, driveways, and parking lots may heave and crack unless carefully designed. This soil is poorly suited to septic tank absorption fields because of its slow permeability. Trees, shrubs, and lawns are fairly easy to establish on this soil.

This soil is in capability subclass IIe and woodland suitability group 2o.

504C—Duluth silt loam, 6 to 12 percent slopes. This gently rolling soil is well drained. It occupies hills, ridges, and knolls on pitted glacial moraines. Delineations are irregular in slope and cover 5 to 50 acres.

Typically, the surface layer is very dark grayish brown silt loam about 4 inches thick. The subsurface layer is brown fine sandy loam about 14 inches thick. The next layer is mixed reddish brown and brown loam about 6 inches thick. The subsoil, about 17 inches thick, is reddish brown loam. The underlying material is reddish brown loam. In a few areas the dominant texture of the profile is sandy loam. In other areas the upper 10 to 30 inches is sandy or silty. Slope is less than 6 percent or more than 12 percent in some areas.

Included in some mapped delineations are small areas of Ronneby, Mahtomedi, and Rifle soils. The Ronneby soils are somewhat poorly drained and occupy wet, low areas. The Mahtomedi soils are excessively drained and formed entirely in glacial outwash, whereas the Duluth soil formed in loamy glacial till. Rifle soils are very poorly drained and formed entirely in organic soil material. They occupy wet depressions. In some lower, sloping areas the soils are moderately well drained.

Permeability of this Duluth soil is slow. Surface runoff is medium. The available water capacity is high. Natural fertility and organic matter content are low.

Most areas of this soil are used for woodland. Cleared areas are mainly cropped to small grains or used for pasture. This soil has good potential for cultivated crops. It has good potential for pasture, hay, and woodland. It has fair potential as building sites and for most sanitary facilities.

This soil is well suited to cultivated crops. Erosion is a hazard and special management is needed to control it. In most places the slopes are too short or too irregular for contour farming or terracing. Minimum tillage or a rotation that includes forage crops also helps to control erosion. If possible, it is best to till this soil across the slope. Gullies and drainageways need to be shaped, seeded, and maintained in grass.

If fertilized and cleared of brush, this soil produces good pasture in spring and fall. Supplemental pasture may be needed during dry summers. Overgrazing must be avoided to prevent erosion and maintain the sod. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil is well suited to trees. Seedling mortality and equipment limitations are slight. Plant competition is moderate, and control of competing weeds and shrubs is

necessary. The hazard of erosion is moderate. Diversions or grassed waterways may be needed to divert water from higher slopes and prevent gully erosion.

This soil has fair suitability for building site development. It is subject to moderate volume changes with changes in soil moisture, and it is moderately susceptible to frost action. Streets, parking lots, and driveways are subject to heaving and cracking unless carefully designed. This soil is poorly suited to septic tank absorption fields because of its slow permeability. Sod, shrubs, and trees are generally easy to establish on this soil.

This soil is in capability subclass IIIe and woodland suitability group 2o.

504D—Duluth silt loam, 12 to 25 percent slopes. This hilly to steep soil is well drained. It occupies convex ridges and side slopes on pitted glacial moraines. Individual areas are irregular in shape and range from 5 to 60 acres.

Typically, the surface layer is very dark grayish brown silt loam about 4 inches thick. The subsoil is about 27 inches thick. The upper part is brown loam. The lower part is dark reddish brown loam. The underlying material is dark reddish brown sandy clay loam. In a few areas the dominant texture of the profile is sandy loam. In other areas the upper 10 to 30 inches is sandy or silty. Slope is less than 12 percent or more than 25 percent in some areas.

Included in some mapped delineations are small areas of Ronneby, Mahtomedi, and Rifle soils. The Ronneby soils are somewhat poorly drained and occupy wet, low areas. The Mahtomedi soils are excessively drained and formed entirely in glacial outwash, whereas the Duluth soil formed in loamy glacial till. The Rifle soils are very poorly drained and formed entirely in organic soil material. They occupy wet depressions.

Permeability of the Duluth soil is slow. Surface runoff is rapid. The available water capacity is high. Natural fertility and organic matter content are low. The surface layer is friable and easily tilled.

Most of this soil is used for woodland. Areas that have been cleared are generally used for pasture. Many areas that have been cleared, however, are developed for urban uses. This soil has fair potential for pasture and woodland. It has fair potential as building sites and poor potential for sanitary facilities. It has poor potential for crops.

This soil is poorly suited to most common crops grown in the survey area. The hazard of erosion is severe, and operation of modern farm machinery is difficult on these slopes. Slopes are generally too short and steep for stripcropping or contouring. Gullies need to be shaped and seeded to grass.

This soil has fair suitability for hay crops and pasture. Grazing must be controlled to maintain good sod. The use of this soil for pasture is effective in controlling erosion. The steeper slopes generally are not suited to hay production because of the hazard of operating machinery.

This soil has fair suitability for trees. Seedling mortality is slight. Plant competition is moderate. Control of weeds, grasses, and brush can be accomplished by cutting or mechanical means. Equipment limitations are moderate due to the steepness of slopes. Because the hazard of erosion is moderate, care should be taken to prevent excessive soil loss.

This soil has fair suitability for building site development although steep slopes are a severe limitation. Changes in soil volume with changes in soil moisture are moderate. Susceptibility to frost action is moderate. Streets, driveways, and concrete slabs on this soil are subject to heaving and cracking unless carefully designed. This soil is poorly suited to septic tank absorption fields because of its slow permeability and steep slopes. Grasses, trees, and shrubs are generally easy to establish.

This soil is in capability subclass VIe and woodland suitability group 2r.

507—Poskin silt loam. This is a very gently sloping, somewhat poorly drained soil. It occurs in drainageways and depressions on outwash plains and valley trains. Individual areas are irregular in shape and range from 5 to 30 acres. Surface runoff from adjacent steeper slopes ponds on this soil for short periods.

Typically the surface layer is black silt loam about 13 inches thick. The subsoil is about 20 inches thick. The upper part is dark grayish brown, mottled silt loam. The middle part is dark brown, mottled silt loam. The lower part is yellowish brown, mottled loam. The underlying material is dark yellowish brown and strong brown gravelly medium and coarse sand. Small areas in some delineations have loam or sandy loam mantles.

Included in mapping are small areas of Antigo, Barronett sandy substratum, Brill, and Rosholt soils. The Antigo and Rosholt soils are well drained and occupy the steeper, higher positions on the landscape. In addition the Rosholt soils have a sandy loam surface mantle. The Brill soils are moderately well drained and are on slight rises. The Barronett sandy substratum soils are poorly drained and are in the lower parts of drainageways and depressions.

Permeability of this Poskin soil is moderate in the silty mantle and very rapid in the underlying sand and gravel. Surface runoff is slow. The available water capacity is moderate. Natural fertility and organic matter content are low. A seasonal high water table is commonly 1 to 3 feet below the surface in undrained areas.

Most areas of this soil are used for pasture or remain idle. Some areas have been drained and are cropped to small grains, corn, and clover. This soil has fair potential for crops, hay, pasture, and woodland. It has poor potential for sanitary facilities and as building sites.

This soil has fair suitability for crops if adequately drained. All crops common to the area can be grown. It is necessary to increase the movement of air and water into and through the soil and to return large amounts of

crop residue to the soil. Applying manure, growing grasses and legumes, and fertilizing are ways of maintaining tilth and fertility and improving internal drainage. Tile drains can generally not be used because adequate outlets are lacking in many areas.

This soil has fair suitability for hay and pasture. During the early spring it is generally too wet for grazing. During the drier summer months the soil becomes droughty and produces poor pasture. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods will help keep the pasture and soil in the best condition.

This soil has only fair suitability for trees. The root zone is restricted by the coarse textured underlying material and seasonal high water table. Seedling mortality is slight. Some site preparation is needed to keep competing vegetation from restricting the growth of planted stock.

This soil is suitable as building sites if the wetness is overcome. Flooding is also a hazard to building on this soil; however, diversions that intercept the runoff from adjacent, steeper slopes can be adequate protection. Basements may be wet unless the water table is lowered or the foundation is placed above the water table. This soil is highly susceptible to frost heaving. Streets, roads, driveways, and sidewalks may be damaged unless properly constructed. This soil is suited to sanitary facilities. Septic tank absorption fields should be specially designed to overcome the limitations of the seasonal high water table and the possible pollution of nearby lakes, streams, and wells. This soil is a good source of sand for construction, but excavation is limited by the seasonal high water table. Trees, shrubs, and grasses are fairly easy to establish and maintain.

This soil is in capability subclass IIw and woodland suitability group 2o.

529—Ripon silt loam, 1 to 2 percent slopes. This level soil is well drained. It formed in a 20- to 40-inch mantle of loess over limestone bedrock on uplands and terraces. Individual areas are irregular in shape and range from 3 to 30 acres.

Typically, the surface layer is very dark gray silt loam about 13 inches thick. The subsoil is dark brown silt loam about 13 inches thick. It is underlain by limestone bedrock. In some areas a thin layer of limestone residuum occurs between the silty mantle and the limestone bedrock. Small areas with slope of more than 2 percent are in some delineations.

Included with this soil in mapping are small areas of Channahon soils which have a silty mantle that is less than 20 inches thick. Also included are small areas of Whalan and Waukegan Variant soils. The Whalan soils are well drained and have glacial outwash between the loess mantle and underlying limestone bedrock. In places there are outcrops of limestone bedrock.

This Ripon soil has moderate permeability. Surface runoff is very slow. The available water capacity is low to moderate depending on the depth to bedrock. Natural fertility is medium, and organic matter content is moderate.

Most areas of this soil are farmed. This soil has fair potential for all crops commonly grown in the survey area and for pasture and hay. It has poor potential for most sanitary facilities and fair potential as building sites.

This soil is best suited to shallow rooted crops such as small grains and soybeans because root penetration is restricted by the underlying bedrock. Droughtiness can limit production during dry periods because the available water capacity of the soil is low. Minimum tillage, a crop rotation that includes forage crops, and the return of crop residues to the soil improve fertility, increase water infiltration, and increase the water holding capacity of the soil. This soil is well suited to irrigation.

This soil has fair suitability for pasture and hay. Shallow rooted grasses and legumes are better suited than deep rooted species. Droughtiness is a problem because of the shallowness of the soil. Proper stocking, rotation grazing, fertilization, and weed control reduce the risk of weeds and less productive grasses invading the pastures. Where pastures are overgrazed or weedy, seeding with approved, more productive species is desirable.

This soil has fair suitability as building sites because of the moderate depth to bedrock. Heavy machinery is needed for excavation. Susceptibility to frost heave is high, and soil strength is low. Roads, streets, and driveways may be damaged unless placed on more suitable base material. Septic tank absorption fields are difficult to install because of the shallowness of the underlying bedrock. Ground water may be polluted by seepage of effluent through the cracks in the bedrock unless specially designed systems are installed. Grasses, trees, and shrubs are generally easy to establish.

This soil is in capability subclass IIs. It is not placed in a woodland suitability group.

529B—Ripon silt loam, 2 to 6 percent slopes. This gently sloping soil is well drained. It formed in a 20- to 40-inch mantle of loess over limestone bedrock on uplands and terraces. Individual areas are irregular in shape and range from 3 to 30 acres.

Typically, the surface layer is very dark grayish brown silt loam about 10 inches thick. The subsoil is dark brown silt loam about 18 inches thick. Ths soil profile is underlain by limestone bedrock. In some areas a thin layer of limestone residuum occurs between the silty mantle and the limestone bedrock. Small areas with slope of less than 2 percent or more than 6 percent are in some delineations.

Included with this soil in mapping are small areas of Channahon soils which have a silty mantle less than 20 inches thick over limestone bedrock. Also included are small areas of well drained Whalan and Waukegan Variant soils. The Whalan soils have a thinner and lighter colored surface layer than the Ripon soil. The Waukegan Variant soils have glacial outwash between the loess

mantle and the underlying limestone bedrock. In places there are outcrops of limestone bedrock.

This Ripon soil has moderate permeability. Surface runoff is slow. The available water capacity is low to moderate depending on the depth to bedrock. Natural fertility is medium, and organic matter content is moderate.

Most areas of this soil are farmed. This soil has fair potential for all crops commonly grown in the survey area and for pasture and hay. It has poor potential for most sanitary facilities and fair potential as building sites.

This soil is best suited to shallow rooted crops such as small grains and soybeans because root penetration is restricted by the underlying bedrock. Droughtiness can limit production during dry periods because the available water capacity is low. Erosion is a hazard on the stronger slopes where stripcropping and mulch tillage should be used. Crop rotation that includes forage crops and the return of crop residues improve fertility and increase water infiltration and the water capacity of the soil. This soil is well suited to irrigation.

This soil has fair suitability for pasture and hay. Shallow rooted grasses and legumes are better suited than deep rooted species. Droughtiness is a problem because of the moderate depth of the soil. Proper stocking, rotation grazing, fertilization, and weed control reduce the risk of weeds and less productive grasses invading the pasture. Where pastures are overgrazed or weedy, interseeding with approved, more productive plant species is desirable.

This soil has fair suitability as building sites because of the moderate depth to bedrock. The underlying bedrock requires heavy machinery for excavation. Susceptibility to frost heave is high, and soil strength is low. Roads, streets, and driveways may be damaged unless placed on more suitable base material. Septic tank absorption fields are difficult to install because of the shallowness of the underlying bedrock. There is a hazard of pollution of ground water by seepage of effluent through the cracks in the bedrock unless specially designed systems are installed. Grasses, trees, and shrubs are generally easy to establish.

This soil is in capability subclass IIe. It is not placed in a woodland suitability group.

529C—Ripon silt loam, 6 to 12 percent slopes. This moderately sloping soil is well drained. It formed in a 20- to 40-inch mantle of loess over limestone bedrock on uplands and terraces. Individual areas are irregular in shape and range from 3 to 35 acres.

Typically, the surface layer is very dark gray and very dark grayish brown silt loam about 11 inches thick. The subsoil is dark brown and brown silt loam about 13 inches thick. The soil profile is underlain by limestone bedrock. In some areas a thin layer of residuum occurs between the silty mantle and the limestone bedrock. Small areas with slope of less than 6 percent or more than 12 percent are in some delineations.

Included with this soil in mapping are small areas of Channahon, Whalan, and Waukegan Variant soils. Channahon soils have a silty mantle that is less than 20 inches thick over limestone bedrock. Whalan soils have a layer of glacial till between the silty mantle and the bedrock. Waukegan Variant soils have a layer of outwash between the silty mantle and the bedrock. In places there are outcrops of limestone bedrock.

This Ripon soil has moderate permeability. Surface runoff is medium. The available water capacity is low to moderate depending on the depth to bedrock. Natural fertility is medium, and organic matter content is moderate.

Areas of this soil are used for crops or hay. This soil has fair potential for crops, pasture, and hay. It has poor potential for most sanitary facilities and fair potential as building sites.

This soil is best suited to shallow rooted crops because of the moderate depth to bedrock. The droughtiness of this moderately deep soil and the hazard of erosion are the main management concerns. Most areas are too small in extent, too irregular in shape, or too short of slope for contour farming or terracing. Minimum tillage, returning crop residue to the soil, and including forage crops in the rotation reduce erosion and improve the available water capacity and fertility of this soil. This soil is well suited to irrigation.

This soil has fair suitability for pasture and hay, but droughtiness is occasionally a problem during the late summer and fall. Shallow rooted grasses and legumes are better suited than deep rooted species. Where pastures are overgrazed or weedy, interseeding with approved or more productive species is desirable. Proper stocking, rotation grazing, fertilization, and weed control decrease the invasion of weeds and less productive grasses.

This soil has fair suitability as building sites because of the moderate depth to bedrock. The underlying bedrock requires large machinery for excavation. This soil is highly susceptible to frost heave and has low strength. Roads, driveways, and parking lots can be damaged unless placed on more desirable base material. Septic tank absorption fields are difficult to install because of the shallowness to bedrock. There is also a hazard of pollution of ground water by seepage of effluent through cracks in the bedrock unless specially designed systems are installed. Grasses, trees, and shrubs are generally easy to establish.

This soil is in capability subclass IIIe. It is not placed in a woodland suitability group.

540—Seelyeville muck. This is a level, very poorly drained soil. It occurs in bogs on plane or slightly concave side slopes on outwash plains and moraines. Individual areas range from 3 to 300 acres. This soil is subject to flooding from runoff from adjacent steeper mineral soils.

Typically, the surface layer is black muck about 7 inches thick. The middle layer is stratified dark brown to

black mucky peat and muck about 36 inches thick. The bottom layer is very dark brown muck. In some places the entire profile is mucky peat. In a few places calcareous coprogenous earth occurs within a depth of 16 to 51 inches.

Included in mapping are a few small areas of Cathro and Markey soils. Cathro soils are loamy within 51 inches of the surface, and Markey soils are sandy within 51 inches. Small islands of mineral soils are also included in mapping.

This Seelyeville soil has moderately rapid permeability. Available water capacity is very high. Runoff is very slow. The organic matter content is very high. Natural fertility is low. A water table is commonly at a depth of less than 2 feet.

Most areas of this soil are left idle. Unless drained, it has poor potential for crops, hay, or pasture. It has poor potential as building sites and for sanitary facilities. It has good potential for wetland wildlife habitat.

The high water table is the main limitation. If drained, this soil is suitable for hay, truck crops, and sod. Before bogs are drained they should be thoroughly investigated to determine the thickness of the muck deposits. The soil surface usually starts to settle after drainage is installed. Frost often occurs early because of the low position on the landscape. Soil blowing can be a problem if row crops are grown. Undrained areas are suitable for pasture and hay if well managed. This soil is well suited to reed canarygrass because it forms a tough, dense sod that can support grazing animals and haying equipment even though the soils are partly wet.

This soil is well suited to wetland wildlife habitat. Suitable water habitat is easy to develop. Wetland food and cover crops can be expected to grow well.

This soil is poorly suited to building site development and sanitary facilities. If this soil is to be used for building, the organic material should be completely removed before fill is added. In some areas, foundations may need to be built on piling or slabs to overcome the soil limitations. This soil is subject to settling. It has very low strength for supporting foundations, is highly compressible, and has low bulk density. Some areas are suitable for parks and recreational areas, such as playgrounds and skating rinks.

This soil is in capability subclass IVw. It is not placed in a woodland suitability group.

541—Rifle muck. This is a level, very poorly drained soil. It is in depressions on moraines, outwash plains, and lake plains. Individual areas range from 10 to 30 acres. This soil is subject to flooding by runoff from adjacent steeper soils.

Typically, the surface layer is black muck about 9 inches thick. The middle layer is brown and strong brown mucky peat about 12 inches thick. The bottom layers are dark yellowish brown and dark brown mucky peat. In some places the entire soil is mucky peat.

Included in mapping are small areas of very poorly drained Cathro and Markey soils. Cathro soils have less than 51 inches of sapric material (muck) over loamy material. Markey soils have less than 51 inches of sapric material over sandy material. Small islands of mineral soils are in some delineations.

This Rifle soil has moderately rapid permeability and very high available water capacity. Natural fertility is low. The organic matter content is very high. The seasonal high water table is at a depth of less than 1 foot.

Most areas of this soil are idle, but some areas are used for pasture, crops, or sod. This soil has poor potential for crops, hay, or pasture. It has poor potential for sanitary facilities and building sites. It has good potential for wetland wildlife habitat.

This soil is too wet for crops unless artificially drained. Because this organic soil subsides when drained, the depth of the peat throughout the area should be determined before bogs are drained. Because this soil is low on the landscape, crops are susceptible to frost damage late in spring and early in fall. Soil blowing may occur on some of the larger bogs if row crops are grown. During dry years peat fires, which are difficult to extinguish, are a hazard.

This soil is well suited to habitat for wetland wildlife. Suitable water habitat is easy to develop. Wetland food and cover crops can be expected to grown well.

This soil is poorly suited to building site development and sanitary facilities. The seasonal high water table and low strength are severe hazards for building. The organic material should be completely removed before fill is added. Where the organic material is so deep that it is not economically feasible to remove all the peat, foundations may need to be built on pilings or slabs. This soil has very low strength for supporting foundations. It is highly compressible and has low bulk density. This soil is poorly suited to septic tank absorption fields because of the high water table. Some areas are suitable for parks and recreational areas such as playgrounds and skating rinks.

This soil is in capability subclass IVw. It is not placed in a woodland suitability group.

543—Markey muck. This is a level, very poorly drained soil. It is in small depressions or on fringes of large bogs on outwash plains. Delineations are irregular in shape and range from 3 to 40 acres. This soil is subject to flooding by runoff from adjacent more sloping soils.

Typically, the surface layer is black muck about 9 inches thick. The next layer is black and brown muck about 21 inches thick. The underlying material is black and olive gray, stratified sandy material. In some areas the organic surface layer is less than 16 inches thick. In other areas the underlying material is sandy loam or loam.

Included in some mapped delineations are small areas of Seelyeville, Isanti, and Lino soils. The Seelyeville soils are very poorly drained and formed entirely in organic soil material, whereas the Markey soil formed in organic

over sandy material. The Isanti soils are very poorly drained and formed in sandy outwash deposits. The Lino soils are somewhat poorly drained and formed in sandy outwash. They are on slight rises.

The Markey soil has moderately rapid permeability. The available water capacity and organic matter content are very high. Natural fertility is low. The seasonal high water table is at a depth of less than 1 foot.

Most areas are in native vegetation. When drained, this soil is used for truck crops, sod, and pasture. This soil has poor potential for most uses. It has good potential for wetland wildlife habitat.

This soil is too wet for crops unless artificially drained. Shallow ditches are needed to lower the water table. They may be difficult to install because the underlying sandy material tends to flow and cause ditch walls to slough. The muck layer tends to subside after drainage and thin after intensive cropping. Because of the low position of this soil, frost is a severe hazard in early fall and late spring. This soil is subject to soil blowing if row crops are grown. Undrained areas are suitable for pasture if well managed. This soil is well suited to reed canarygrass, which forms a tough, dense sod that can support grazing animals and haying equipment even though the soils are partly wet.

Many areas are suitable for wildlife habitat. Suitable water habitat is relatively easy to establish. Water is generally fairly easy to maintain at a desired level. Wetland food and cover plants can be expected to grow well.

This soil is poorly suited to building site development and sanitary facilities because of wetness, flooding, and very poor strength of the organic soil material. The upper part of this soil has low bulk density and is very compressible. It is highly susceptible to frost action, which adds to the overall poor construction characteristics. If this soil is to be used for building, it is recommended that all organic material be completely removed before till is added. This soil is poorly suited to septic tank absorption fields because of the high water table. Some areas are suitable for parks and recreational areas such as playgrounds and skating rinks.

This soil is in capability subclass IVw. It is not placed in a woodland suitability group.

544—Cathro muck. This is a level, very poorly drained soil. It is in small depressions or in fringes of large bogs on glacial till and lake plains. Delineations are irregular in shape and range from 5 to 25 acres. This soil is subject to flooding by runoff from adjacent more sloping soils.

Typically, the surface layer is very dark gray and very dark brown muck about 32 inches thick. The next layer is dark brown mucky peat about 6 inches thick. The underlying material is black and grayish brown loam, silt loam, and sandy loam. In some areas the organic surface mantle is less than 16 inches thick.

Included in some mapped delineations are small areas of Seelyeville, Prebish, Bluffton, and Ronneby soils. The Seelyeville soils are very poorly drained and formed entirely in organic soil material, whereas the Cathro soil formed in organic over loamy material. The Prebish and Bluffton soils are very poorly drained and formed entirely in loamy glacial till. The Ronneby soils are somewhat poorly drained and formed in glacial till. They occupy slight rises.

Permeability of this Cathro soil varies from moderately slow to moderately rapid in the organic layers and is moderately slow to moderate in the mineral underlying material. The available water capacity is high, and the organic matter content is very high. Natural fertility is low. The seasonal high water table is at or within 1 foot of the surface unless artificially drained.

Most of this soil is in native vegetation or is cleared and used for pasture. It has poor potential for crops and fair potential for pasture. It has poor potential as building sites and for sanitary facilities. It has good potential for wetland wildlife habitat.

Because it is excessively wet and is susceptible to soil blowing and frost action, this soil is seldom planted to crops. If drained, it has fair suitability for some general crops and pasture. Outlets for drainage are lacking in many areas. Wetland grass species which form a tough, dense sod that can support animals and haying equipment make these areas more desirable for pasture and hay. Because this soil is low on the landscape, the hazard of frost damage is severe during the growing season. The soil remains cold and dries out slowly in the spring, even with drainage.

Many areas are suitable for wetland wildlife habitat. Suitable water habitat is generally easy to develop. Water can be maintained at desired levels fairly easily. Wetland food and plants can be expected to grow well.

This soil is poorly suited to building site development and sanitary facilities because of wetness and flooding. The high susceptibility to frost action and low soil strength also add to overall poor construction characteristics. If this soil is to be used for building, the organic material should be completely removed before fill is added. This soil is poorly suited to septic tank absorption fields because of the high water table. Some areas are suitable for parks and recreational areas such as playgrounds and skating rinks.

This soil is in capability subclass IVw. It is not placed in a woodland suitability group.

552—Kerston muck. This is a level, very poorly drained soil. It occurs on first bottoms of flood plains of the Mississippi River. The surface is commonly hummocky. Mapped areas are commonly 10 to 100 acres. This soil is subject to flooding from stream overflow.

Typically, the surface layer is black, well decomposed sapric material (muck) about 9 inches thick. The next layer, about 11 inches thick, is black, well decomposed sapric material. The underlying material is stratified black and very dark gray silt loam and well decomposed sapric material.

Included in mapping are small areas of Chaska soils and Udorthents, wet substratum. Chaska soils formed entirely in mineral soil materials. The Udorthents, wet substratum, are areas of fill material over wet mineral or organic soils. These included soils make up less than 5 percent of the acreage.

Permeability of the Kerston soil is moderate or moderately rapid. The available water capacity and organic matter content are high. Natural fertility is low. The water table is typically the same as that of the adjacent stream.

Most of this soil is in native vegetation or is cleared and used for pasture. This soil has poor potential for most uses. It has good potential for wetland wildlife habitat.

Because it is excessively wet and susceptible to soil blowing and frost action, this soil is seldom planted to crops. If drained, it has fair suitability for some crops and pasture. Outlets for drainage are lacking in many areas. Because of its low position on the landscape this soil is often subject to severe frost damage during the growing season. It remains cold and dries out slowly in the spring, even if drained.

This soil is poorly suited to building site development and sanitary facilities because it is wet and subject to flooding. The high susceptibility to frost action and low soil strength also add to overall poor construction characteristics. If this soil is to be used for building, the organic material should be completely removed before fill is added. This soil is poorly suited to septic tank absorption fields because of the high water table. Some areas are suitable for parks and recreational areas such as playgrounds and skating rinks.

Many areas are suitable for wetland wildlife habitat. Suitable water habitat is generally easy to develop. Water can be maintained at desired levels fairly easily. Wetland food and plants can be expected to grow well.

This soil is in capability subclass IVw. It is not placed in a woodland suitability group.

852B—Urban land-Copaston complex, 0 to 8 percent slopes. This complex is on a level to moderately sloping landscape where topography is controlled by bedrock. It is 50 percent Urban land and about 20 percent well drained Copaston soils, mainly in undisturbed areas. Delineations are irregular in shape and range from 5 to 200 acres.

The Urban land part of this complex is dominantly developed for residential use. A few small shopping centers and their adjacent parking lots are included.

In undisturbed areas the Copaston soil has a surface layer of very dark brown loam about 8 inches thick. The subsoil is dark brown sandy loam about 10 inches thick. Limestone or sandstone bedrock is at a depth of 18 inches. In some areas the soil is well drained and has a loamy mantle more than 20 inches thick over bedrock. In some places the soil has been removed and the underlying material is exposed. Other areas are covered with fill of varying depths.

Areas of the Faxon soils are included in mapping. They are in the lower positions on the landscape and are poorly and very poorly drained.

Permeability of the Copaston soil in this complex is moderate. Natural fertility and the available water capacity are low. Depth to bedrock is 12 to 20 inches. Surface runoff from this complex is rapid and generally is channeled in storm sewers.

The Copaston soil in this unit is used for parks, lawns, and gardens or will be the site for future building. These areas have fair potential for lawns, vegetable and flower gardens, trees, shrubs, and as building sites.

The major limitations for growing grasses, gardens, and trees are the low fertility and the low available water capacity of the Copaston soil. Frequent applications of fertilizer and water are necessary to establish and maintain vegetation. Sodding produces a quick permanent cover and helps to reduce erosion. Trees and shrubs that are resistant to drought should be planted for a better survival rate.

The Copaston soil has fair suitability as building sites because of the shallow depth to rock. Excavating the underlying bedrock is difficult. Erosion should be controlled during and immediately following construction. The surface soil should be stripped and returned after construction. Because many areas are covered by impervious structures, the volume of runoff is large and can cause severe erosion if it is not properly channeled. Water may seep into basements in the lower areas unless they are tile drained or are placed above the water level. Onsite investigations are recommended to best determine potentials and limitations of this complex for any proposed use.

This complex is not assigned to any interpretative group.

857—Urban land-Waukegan complex, 0 to 3 percent slopes. This level to very gently sloping complex is on outwash plains. It consists of Urban land and of undisturbed areas of well drained Waukegan soils. Up to 90 percent of this complex is Urban land. Individual areas range from 10 to 150 acres.

The Urban land is dominantly developed for residential use. It has a few small shopping centers and their adjacent parking lots.

In undisturbed areas the Waukegan soil has a surface layer of very dark brown silt loam about 10 inches thick. The subsoil is about 21 inches thick. The upper part is dark yellowish brown silt loam, and the lower part is yellowish brown coarse sand. The underlying material is light yellowish brown coarse sand and fine gravel. In places the underlying material is dominantly sand. In some places the soil has been removed and the underlying material is exposed. Other areas are covered with fill of varying depths.

Included in mapping are areas of Brill, Dickman, Grays, and Richwood soils. The moderately well drained Brill soils and the well drained Richwood soils have a thicker

silty mantle underlain by the sand and gravel. The Dickman soils are somewhat excessively drained and have a sandy loam surface layer and subsoil. The Grays soils are well drained and have silty textures to depths greater than 5 feet.

The permeability of the Waukegan soil is moderate in the silty layers and rapid in the underlying material. It has a moderate available water capacity. Runoff from these areas is slow. Natural fertility is medium.

The Waukegan soil in this unit is used for parks, lawns and gardens, or will be used as building sites. It has good potential for lawns, vegetable and flower gardens, trees, shrubs, and for building site development.

The Waukegan soil is well suited to lawns, gardens, trees, and shrubs. If the sandy underlying material is exposed, however, topdressing with loamy material will help to establish and maintain a vegetative cover. Sodding produces a quick permanent cover and reduces erosion.

The Waukegan soil is well suited to building site development. There are few limitations. Sidewalls in the underlying material have poor stability and may cave in during excavation. Temporary retaining walls help to alleviate this problem. Water may seep into basements in the lower areas if the basements are not properly designed and protected. Onsite investigations are recommended to best determine the suitability of this complex for any proposed use.

This complex is not assigned to any interpretative group.

857C—Urban land-Waukegan complex, 3 to 15 percent slopes. This very gently sloping to moderately steep complex is on outwash plains. It consists mostly of Urban land and well drained Waukegan soils in undisturbed areas. Up to 90 percent of this complex is Urban land. Individual areas range from 10 to 150 acres.

The Urban land part is dominantly developed for residential use. A few small shopping centers and their adjacent parking lots are included.

In undisturbed areas the Waukegan soil has a surface layer of very dark gray silt loam about 8 inches thick. The subsoil is dark brown or brown silt loam about 16 inches thick. The underlying material is yellowish brown and light yellowish brown stratified medium and coarse sand and fine gravel. In places the underlying material is dominantly sand. In some places the soil has been removed and the underlying material is exposed. Other areas are covered with fill of varying depths.

Included in mapping are areas of Brill, Dickman, Grays, and Richwood soils. The moderately well drained Brill soils and well drained Richwood soils formed in a thicker silty mantle over sand and gravel. The Dickman soils are somewhat excessively drained and have a sandy loam surface layer and subsoil. The Grays soils are well drained and have a silty texture to a depth of more than 5 feet.

The permeability of the Waukegan soil is moderate in the silty layers and rapid in the underlying sandy material. The available water capacity is moderate. Surface runoff is medium to rapid. Natural fertility is medium.

The Waukegan soil is used for parks, lawns, and gardens or is the site for future building. It has good potential for lawns, vegetable and flower gardens, trees, shrubs, and for building site development.

If the surface layer is relatively undisturbed, vegetation is easy to establish and maintain on this soil. However, if the sandy underlying material is exposed, topdressing with loamy material is desirable before seeding lawns. On the stronger slopes, laying sod reduces the hazard of erosion. Unless runoff is properly channeled, it can cause severe erosion.

The Waukegan soil is well suited to building site development, although slope is a limitation for some uses. This soil erodes easily, and erosion needs to be controlled, especially during and immediately after construction (fig. 12). The surface soil that is stripped off should be returned after construction to permit easier revegetation. Excavation of this soil is easy, but sidewalls in the underlying material have poor stability. They can be prevented from caving in by use of temporary retaining walls. Because many areas are covered by impervious structures, the volume of runoff is large and can cause severe erosion if not channeled. Water may seep into basements in the lower areas unless they are tile drained or are placed above the water level. Onsite investigation is needed to determine potentials and limitations of this complex for any proposed use.

This complex is not assigned to any interpretive group.

858—Urban land-Chetek complex, 0 to 3 percent slopes. This level to gently undulating complex is on outwash plains. It consists mostly of Urban land and of somewhat excessively drained Chetek soils in undisturbed areas. Up to 90 percent of this complex is Urban land.

The Urban land part is dominantly developed for residential use. A few small shopping centers and the adjacent parking lots are included.

In undisturbed areas the Chetek soil has a surface layer of dark brown sandy loam about 6 inches thick. The subsoil is about 14 inches thick. The upper half is brown sandy loam, and the lower part is brown gravelly sand. The underlying material is reddish brown gravelly sand. In some places slope is more than 3 percent. In some places the soil has been removed and the underlying material is exposed. Other areas are covered with fill of varying depths.

Included in mapping are small areas of the Emmert, Mahtomedi, and Rosholt soils. Emmert and Mahtomedi soils have a sandier surface mantle than Chetek soils. Rosholt soils are well drained and have a thicker sandy loam mantle than Chetek soils.

Permeability of the Chetek soil is moderately rapid in the surface and subsurface layers and rapid in the underlying material. Natural fertility and the available water holding capacity are low. Runoff is slow.

Figure 12.—Houses on Urban land-Waukegan complex, 3 to 15 percent slopes. Retaining walls are needed to stabilize the underlying Waukegan soils.

The Chetek soil is used for parks, lawns, and gardens or is the site for future building. It has fair potential for lawns, gardens, trees, and shrubs. It has good potential for building site development and public sewers.

The major limitations for grasses, gardens, and trees are the low fertility and low available water holding capacity of the Chetek soil. Frequent applications of fertilizer and water are necessary. Sodding produces a quick permanent cover and reduces erosion. Recommended and adapted plant species should be planted for a better survival rate. In some places the underlying material has been exposed and should be topdressed with loamy material before planting.

The Chetek soil is well suited to building site development. Limitations are few. Sidewalls in the underlying material have poor stability and may cave in during excavation. Temporary retaining walls help to prevent this. Water may seep into basements in the lower areas if they are not properly designed and protected. Onsite investigation is needed to determine the suitability of this complex for any proposed use.

This complex is not assigned to any interpretive group.

858C—Urban land-Chetek complex, 3 to 15 percent slopes. This complex consists mostly of Urban land and undulating to hilly, somewhat excessively drained Chetek soils on outwash plains. Up to 90 percent of this area is Urban land. Delineations are irregular in shape and range from 5 to 80 acres.

The Urban land is mainly developed for residential uses. A few small shopping centers and their adjacent parking lots are included.

In undisturbed areas the Chetek soils typically have a surface layer of brown sandy loam about 6 inches thick

and a reddish brown sandy loam subsoil about 12 inches thick. The underlying material is strong brown gravelly sand. In some places slope is less than 3 percent or more than 15 percent. In some places the soil has been removed and the underlying material is exposed. Other areas are covered with fill of varying depths.

Included in mapping are areas of Rosholt, Emmert, and Mahtomedi soils. Rosholt soils are well drained and have a thicker sandy loam mantle over sands and gravel than the Chetek soils. Emmert and Mahtomedi soils have a sandier surface mantle than the Chetek soils.

Permeability of the Chetek soil is moderately rapid in the surface and subsurface layers and rapid in the underlying material. Natural fertility and the available water holding capacity are low. Runoff is medium to rapid.

The Chetek soils are used for parks, lawns, and gardens or as the site for future building. They have fair potential for lawns, gardens, trees, and shrubs and are good potential building sites.

The major limitations for grasses, gardens, and trees are the low natural fertility and low available water capacity of the Chetek soil. Frequent applications of fertilizer and water are necessary. Sodding produces a quick permanent cover and reduces erosion. Planting adapted and recommended species increases the survival rate. In some places where the underlying material is exposed, topdressing with loamy material is desirable before planting.

The Chetek soil is well suited to building site development although slope is a limitation for some uses. This soil erodes easily, and erosion control, especially during and immediately following construction, is desirable. The surface soil should be stripped and returned after construction to allow easier revegetation. Excavation is easy, but stability in the underlying material is poor. Caving in of sidewalls can be reduced by use of temporary retaining walls. Because many areas are covered by impervious structures, the volume of runoff is large. It can cause severe erosion if not properly channeled. Water may seep into basements in the lower areas unless they are tile drained or are placed above the water level. Onsite investigation is recommended to determine the potentials and limitations of this complex for any proposed use.

This complex is not assigned to any interpretative group.

859B—Urban land-Zimmerman complex, 1 to 8 percent slopes. This complex consists of Urban land and very gently sloping to moderately sloping, excessively drained Zimmerman soils on outwash plains. Up to 90 percent of the complex is Urban land. Delineations are irregular in shape and range from 5 to 300 acres.

The Urban land part of this complex is dominantly developed for residential use. A few small shopping centers and their adjacent parking lots are included.

In undisturbed areas the Zimmerman soil typically has a surface layer of dark grayish brown loamy fine sand about 15 inches thick. The subsoil is stratified light gray to pale brown fine sand with thin, discontinuous bands of dark loamy fine sand 1/4 to 1 inch thick. In places these bands are thick enough to be the dominant part of the subsoil. In some places the soil has been removed and the underlying material is exposed. Other areas are covered with fill of varying depths.

Included in mapping are small areas of Dickman and Sparta soils. The Dickman soils have a loamy mantle over the sand. The Sparta soils lack the textured bands of the Zimmerman soil and have a darker colored surface layer.

Permeability is rapid in the Zimmerman soil. It has low natural fertility and low available water capacity. Surface runoff is rapid and generally is channeled into storm sewers.

The major limitation to establishing lawns, gardens, and trees is the low available water capacity and low natural fertility of the Zimmerman soil. Places where the underlying material is exposed should be topdressed with loamy material before planting grasses or trees. Frequent watering and fertilization are necessary to keep lawns, gardens, trees, and shrubs growing well. Sodding produces a quick permanent cover and reduces erosion. Planting trees and shrubs that are resistant to drought will improve seedling survival and growth.

The Zimmerman soil is well suited to building site development. Limitations are few. Because this soil erodes easily, erosion control, especially during and immediately following construction, is desirable. The surface soil should be stripped and returned after construction to allow for easier revegetation. Excavation is easy, however sidewall stability in the underlying material is poor. Caving in of sidewalls can be reduced by use of temporary retaining walls. Because many areas are covered by impervious structures, the volume of runoff is large and can cause severe erosion if not properly channeled. Water may seep into basements in the lower areas unless they are tile drained or are placed above the water level. Onsite investigation is recommended to determine the potentials and limitations of this complex for any proposed use.

This complex is not assigned to any interpretative group.

860C—Urban land-Hayden-Kingsley complex, 3 to 15 percent slopes. This undulating to hilly complex is on knolls and hillsides of moraines. It consists mostly of Urban land and of well drained Hayden and Kingsley soils in undisturbed areas. Up to 90 percent of this complex is Urban land. Delineations are irregular in shape and range from 5 to 300 acres.

The Urban land is dominantly developed for residential use. A few small shopping centers and their adjacent parking lots are included.

Typically, the Hayden soils have a surface layer of very dark grayish brown fine sandy loam about 4 inches thick and a dark brown loam subsurface layer about 8

inches thick. The subsoil is dark yellowish brown loam about 30 inches thick. The underlying material is olive brown calcareous loam. In some areas reddish brown or dark reddish brown sandy loam is below a depth of 36 to 60 inches. In some places the soil has been removed and the underlying material is exposed. Other areas are covered with fill of varying depths.

Typically, the Kingsley soils have a grayish brown sandy loam surface layer about 6 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown sandy loam. The lower part is reddish brown sandy loam. The underlying material is dark reddish brown sandy loam.

Included in mapping are small areas of Braham and Nessel soils. The Braham soils are well drained and have a loamy sand mantle over the loamy glacial till. The Nessel soils are moderately well drained and are downslope from Hayden soils.

Permeability is moderate in the Hayden soil and moderately slow in the Kingsley soil. The available water capacity of these soils is moderate to high, and the natural fertility of both soils is moderate. Runoff from this complex is rapid.

The soils in this complex are used for parks, lawns, and gardens or are future building sites. They have good potential for lawns, gardens, trees, shrubs, and as building sites.

The Hayden and Kingsley soils are well suited to lawns, gardens, trees, and shrubs. Where the subsurface has been exposed by construction, a topdressing of loamy soil material is needed for plant survival. Sodding produces a quick permanent cover and reduces erosion. Planting adapted plant species increases the survival rate.

The soils in this complex are well suited to building site development. Slope is a limitation for most uses. Erosion control, especially during and immediately following construction, is desirable. The surface soil should be stripped and returned after construction to permit easier revegetation. Roads, driveways, and parking lots should be placed on more suitable base material to prevent the damage resulting from low strength. Because many areas are covered with impervious structures, the volume of runoff is large and can cause severe erosion if not properly channeled. Water may seep into basements in the lower areas unless they are tile drained or are placed above the water levels. Onsite investigation is recommended to determine the potentials and limitations of this complex for any proposed use.

This complex is not assigned to any interpretative group.

860D—Urban land-Hayden-Kingsley complex, 15 to 25 percent slopes. This hilly to steep complex is on knolls and sides of hills and ridges of moraines. It consists mostly of Urban land and of well drained Hayden and Kingsley soils in undisturbed areas. Up to 90 percent is Urban land. Delineations are irregular in shape and range from 15 to 100 acres.

The Urban land is dominantly developed for residential use. A few small shopping centers and their adjacent parking lots are included.

Typically, the Hayden soils have a dark brown fine sandy loam surface layer about 6 inches thick. The subsoil is yellowish brown loam about 30 inches thick. In some areas reddish brown or dark reddish brown sandy loam is below a depth of 36 to 60 inches. In some places the soil has been removed and the underlying material is exposed. Other areas are covered with fill of varying depths.

Typically, the Kingsley soils have a grayish brown sandy loam surface layer about 4 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown sandy loam, and the lower part is reddish brown sandy loam. The underlying material is dark reddish brown sandy loam.

Included in mapping are areas of Braham and Nessel soils. Braham soils are well drained and have a loamy sand mantle over loamy glacial till. Nessel soils are moderately well drained and are downslope from Hayden soils.

Permeability is moderate in the Hayden soil and moderately slow in the Kingsley soil. The available water capacity of these soils is moderate to high and their natural fertility is moderate. Runoff from this complex is rapid.

The soils in this complex are used for parks, lawns, and gardens or are future building sites. They have fair potential for lawns, gardens, trees, shrubs and as building sites.

Because slopes are steep, there is a severe hazard of erosion. Areas that have been disturbed should be reseeded and mulched as soon as possible to reduce erosion. Sodding produces a quick permanent cover, which reduces runoff and erosion. In some areas where the underlying material has been exposed, topdressing of a loamy soil material should be applied to improve the survival and growth of plants. Because trees and shrubs have different requirements, adapted species should be planted for a better survival rate.

The soils in this complex have fair suitability for building site development. The steep slope is a limitation for most uses. Erosion needs to be controlled, especially during and immediately following construction. The surface soil that is stripped off should be returned after construction to allow for easier revegetation. Roads, driveways, and parking lots should be placed on more suitable base material to prevent the damage resulting from low strength. Designing buildings to fit the slope reduces the need for grading. It also reduces erosion and sedimentation. Because many areas are covered by impervious structures, the volume of runoff is large and causes severe erosion if not properly channeled. Water may seep into basements in the lower areas unless they are tile drained or are placed above the water level. Onsite investigation is recommended to determine the potentials and limitations of this complex for any proposed use.

This complex is not assigned to any interpretative group.

861C—Urban land-Kingsley complex, 3 to 15 percent slopes. This undulating to hilly complex is on knolls and hillsides of glacial till moraines. It consists of Urban land and of well drained Kingsley soils in undisturbed areas. Up to 90 percent is Urban land. Delineations are irregular in shape and range from 5 to 300 acres.

The Urban land unit is dominantly developed for residential use. A few small shopping centers and their adjacent parking lots are included.

Typically, the Kingsley soils have a grayish brown sandy loam surface layer about 6 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown sandy loam. The lower part is reddish brown sandy loam. The underlying material is dark reddish brown sandy loam. In some places the surface soil is sandier. In some places the soil has been removed and the underlying material is exposed. Other areas are covered with fill of varying depths.

Included in mapping are areas of Duluth, Freer, Prebish, and Ronneby soils. The Duluth soils are well drained and formed in loamy glacial till. The Freer, Prebish, and Ronneby soils are more poorly drained and all occur in shallow depressions. Many of these depressions are filled during construction to overcome the high water table.

The Kingsley soil has moderately slow permeability. It has a moderate available water capacity and is medium in natural fertility. Runoff is medium to rapid.

The soils in this complex are used for parks, lawns, and gardens or are future building sites. Potential is good for lawns, gardens, trees, shrubs, and for building site development.

The Kingsley soils are well suited to lawns, gardens, trees, and shrubs. Where the subsurface has been exposed by construction, a topdressing of loamy soil material is needed for better survival of plants. Sodding produces a quick permanent cover that reduces erosion. Adapted species should be planted for a better survival rate.

The Kingsley soils are well suited to building development. Slope is a limitation for most uses. Erosion needs to be controlled, especially during and immediately following construction. The surface soil that is stripped off should be returned after construction to allow for easier revegetation. Because many areas are covered with impervious structures, the volume of runoff is large. It can cause severe erosion if not properly channeled. Water may seep into basements in the lower areas unless they are tile drained or are placed above the water level. Onsite investigation is recommended to determine the potentials and limitations of this complex for any proposed use.

This complex is not assigned to any interpretative group.

861D—Urban land-Kingsley complex, 15 to 25 percent slopes. This hilly to very steep complex is on knolls and on sides of hills and ridges of glacial till moraines. It consists of Urban land and of well drained Kingsley soils in undisturbed areas. Up to 90 percent is Urban land. Delineations are irregular in shape and range from 20 to 200 acres.

The Urban land is dominantly developed for residential use. A few small shopping centers and their adjacent parking lots are included.

Typically, the Kingsley soils have a dark gray sandy loam surface layer about 3 inches thick. The subsurface layer is grayish brown sandy loam about 12 inches thick. The subsoil is dark brown and reddish brown sandy loam about 26 inches thick. The underlying material is reddish brown sandy loam. In some places the surface layer is sandier. In some places the soil has been removed and the underlying material is exposed. Other areas are covered with fill of varying depths.

Included in mapping are a few small areas of Duluth, Freer, Ronneby, and Prebish soils. The Duluth soils are well drained and formed in loamy glacial till. The Freer, Prebish, and Ronneby soils are more poorly drained and occupy depressions or small drainageways. Many of these depressions are filled during construction to overcome a high water table.

The permeability of the Kingsley soils is moderately slow. The available water capacity is moderate, and natural fertility is medium. Runoff is medium to rapid.

The soils in this complex are used for parks, lawns, and gardens or are future building sites. They have fair potential for lawns, gardens, trees, shrubs, and as building sites.

Because slopes are steep, there is a severe hazard of erosion. Areas that have been disturbed should be reseeded and mulched as soon as possible to reduce erosion. Sodding produces a quick permanent cover that reduces runoff and erosion. In some areas where the underlying material has been exposed, a topdressing of a loamy soil material should be applied. This improves the survival and growth of plants. Because trees and shrubs have different requirements, adapted species should be planted for a better survival rate.

The Kingsley soils have fair suitability as building sites. The steep slopes are limitations for most uses. Erosion needs to be controlled, especially during and immediately following construction. The surface soil that is stripped off should be returned after construction to allow for easier revegetation. Designing buildings to fit the slope reduces the need for grading and also reduces erosion and sedimentation. Because many areas are covered with impervious structures, the volume of runoff is large. It causes severe erosion if not properly channeled. Water may seep into basements in the lower areas unless they are tile drained or are placed above the water level. Onsite investigation is recommended to determine the potentials and limitations of this complex for any proposed use.

This complex is not assigned to any interpretative group.

862—Urban land-Dundas complex, 1 to 4 percent slopes. This very gently sloping complex is on glacial till uplands. It consists of Urban land and of poorly drained Dundas soils in undisturbed areas, mostly in drainageways and low areas. Up to 90 percent is Urban land. Delineations are irregular in shape and range from 5 to 75 acres.

This Urban land is dominantly developed for residential use. A few small shopping centers and their adjacent parking lots are included.

Typically, the surface layer of the Dundas soil is very dark gray fine sandy loam about 9 inches thick. The subsurface layer is strong brown mottled sandy clay loam about 4 inches thick. The subsoil is grayish brown, mottled sandy clay loam about 32 inches thick. The underlying material is grayish brown, mottled loam. In some places the soil has been removed and the underlying material is exposed. Other areas are covered with fill of varying depths.

Included in mapping are small areas of Hayden, Nessel, and Webster soils. The well drained Hayden and the moderately well drained Nessel soils are on the higher parts of the landscape. The Webster soil is poorly drained and occupies small depressions.

Permeability is moderately slow in the Dundas soils. The available water capacity is high, and the natural fertility is moderate. A seasonal high water table occurs at a depth of 1 to 3 feet. Runoff is slow. Most areas are artificially drained by sewer systems, gutters, drainage tiles, and, to a lesser extent, surface ditches.

The Dundas soils are used for parks, lawns, and gardens or are future building sites. They have fair potential for lawns, gardens, trees, and shrubs. They generally have poor potential as building sites.

Because the Dundas soils have a high seasonal water table, planted trees and shrubs should have a tolerance for wetness. Drainage or land forming may be needed to prevent prolonged wetness. Seedbeds may be difficult to prepare for lawns in areas that have been compacted by construction equipment.

The Dundas soils are poorly suited to building site development because of wetness and low soil strength. Where possible, dwellings and small buildings should be constructed without basements. If basements are needed, tile should be placed around footings or the foundations should be placed above the water table on fill material. Special precautions may need to be taken to prevent foundation damage caused by moderate changes in volume that result from changes in soil moisture. Those soils are highly susceptible to frost action because they have a seasonal high water table. Roads, driveways, and parking lots are subject to heaving and cracking unless they are placed on more suitable base material. Onsite investigation is recommended to determine the potentials and limitations of this complex for any proposed use.

This complex is not assigned to any interpretative group.

863—Urban land-Lino complex, 0 to 3 percent slopes. This level to very gently sloping complex is on outwash plains on uplands. It consists mostly of Urban land and of somewhat poorly drained Lino soils in undisturbed areas. Up to 90 percent is Urban land. Individual areas range from 10 to 150 acres.

The Urban land is dominantly developed for residential use. A few small shopping centers and their adjacent parking lots are included.

Typically, the Lino soils have a dark grayish brown loamy fine sand surface layer about 9 inches thick. The subsoil is about 27 inches thick. The upper part is pale brown, mottled loamy fine sand, and the lower part is light brownish gray, mottled loamy fine sand. The underlying material is light brownish gray, mottled fine sand. In some places the soil has been removed and the underlying material is exposed. Other areas are covered with fill of varying depths.

Included in mapping are a few small areas of Isanti, Markey, Soderville, and Zimmerman soils. Isanti and Markey soils occur in the deeper parts of some depressions or drainageways and are very poorly drained. Soderville soils are in slightly lower posititons and are somewhat poorly drained. Zimmerman soils occur on small hills and are excessively drained.

Permeability of the Lino soils is rapid. The available water capacity is low, and natural fertility is low. A seasonal high water table occurs at a depth of 2 to 4 feet. Runoff is slow. Most areas are artificially drained by sewer systems, gutters, drainage tiles, and, to a lesser extent, surface ditches.

The Lino soils are used for parks, lawns, and gardens or are building sites. They have fair potential for lawns, gardens, trees, and shrubs. They have fair potential as building sites.

It is difficult to establish lawns, trees, and shrubs on the Lino soils because they have low fertility and low available water capacity. Frequent irrigation and fertilization are needed to maintain good plant growth. A loamy topdressing should be applied before establishing lawns. Laying sod is preferable to seeding because it provides a quicker permanent cover and reduces soil blowing. Deep rooting plants, such as trees, are hindered in growth by the seasonal high water table unless adapted species are planted.

The Lino soils have only fair suitability as building sites because of wetness. Where possible, buildings should be constructed without basements. If basements are needed, tile should be placed around foundations or the foundations should be placed above the water table on fill material. This soil is moderately susceptible to frost action, and streets, parking lots, and sidewalks may heave and crack unless carefully designed. Onsite investigation is recommended to determine the potentials and limitations of this complex for any proposed use.

This complex is not assigned to any interpretative group.

896C—Mahtomedi-Kingsley complex, 3 to 12 percent slopes. This map unit consists of undulating to gently rolling soils that are excessively drained and well drained. They are on convex ridgetops and side slopes on ground and terminal moraines. These soils are so intricately mixed that it is impractical to separate them in mapping. Mahtomedi soils make up 30 to 65 percent of this complex and Kingsley soils make up 20 to 40 percent. Individual areas are irregular in shape and range from 2 to 30 acres.

Typically, the excessively drained Mahtomedi soils have a surface layer of dark yellowish brown loamy sand about 8 inches thick. The subsoil, about 30 inches thick, is reddish brown coarse sand in the upper part and reddish brown gravelly coarse sand in the lower part. The underlying material is light reddish brown sand. In some areas the underlying material is gravelly or the surface layer is more than 8 inches thick and loamy.

Typically, the well drained Kingsley soils have a grayish brown sandy loam surface layer about 6 inches thick. The subsoil is dark brown and reddish brown sandy loam about 26 inches thick. The underlying material is dark reddish brown sandy loam. In some areas the subsoil is loam.

Included with this unit in mapping are areas of Demontreville, Santiago, Ronneby, and Poskin soils. Santiago soils have a silty surface layer and are underlain by glacial till. Ronneby and Poskin soils are somewhat poorly drained and occur in small depressions. Also included, on the Mississippi River bluffs in southeastern Ramsey County, are well drained loamy soils underlain by bedrock within a depth of 40 inches.

Permeability is rapid in the Mahtomedi soils and moderately slow in the Kingsley soils. The available water capacity is very low in the Mahtomedi soils and moderate in the Kingsley soils. Surface runoff is medium to rapid in both soils. The Mahtomedi soils are low in natural fertility and organic matter content. The Kingsley soils are medium in natural fertility and moderate in organic matter content.

Some areas of these soils are farmed, but most are used for woodland or permanent pasture. Potential is fair for small grains and for pasture, hay, and woodland. It is poor for cultivated crops. This unit has good potential as building sites and fair to poor potential for sanitary facilities.

The erosion hazard is moderate. These soils can be droughty in summer because they have low available water capacity. They are usually better suited to early-maturing crops than to crops which mature in the late summer months. Slopes are generally too short or too irregular to contour stripcrop or terrace. Minimum tillage and returning a maximum amount of crop residue to the soil help control erosion and conserve soil moisture. Fertilization is needed to offset the low natural fertility. Numerous rocks and pebbles on the surface may hinder tillage.

The soils in this complex have only fair suitability for pasture and hay crops. Droughtiness is a problem on the Mahtomedi soil because it has low available water capacity. These soils provide fair pasture in spring and fall, but production is low during hot, dry summer months. Supplemental pasture may be needed in summer. Reseeding pasture and hayland with drought-resistant plant species increases production. Proper stocking, rotation grazing, fertilization, and weed control will help maintain a cover of the more productive plant species.

The soils in this complex have only fair suitability for trees. Seedling mortality depends on available water and can be expected to be high if a dry season follows planting. Furrow planting on the contour or planting in existing vegetation reduces erosion and conserves moisture. Control of competing vegetation is essential for establishing trees. Diversions or grassed waterways may be needed to divert water from higher slopes and to prevent erosion.

These soils are well suited to building site development. In places, slope is a limitation for some uses. Because Mahtomedi soils are noncohesive, gullies can easily develop from the increased runoff from roofs and trees. Erosion needs to be controlled. Excavation is relatively easy, but sidewalls in the Mahtomedi soil have such poor stability that they may cave in. This can be prevented by using temporary retaining walls or by enlarging the trenches. Septic tank absorption fields function well on the Mahtomedi soils. However, there is hazard of pollution of underground water supplies and nearby lakes and streams unless systems are specially designed. Specially designed septic tank absorption systems are needed on the Kingsley soils to overcome the moderately slow permeability. A hazard of sidehill seepage may exist on the steeper slopes. Vegetation is fairly easy to establish and maintain where the surface layer is loam. Soils that have a sandy or gravelly surface layer may need to be topdressed with loamy material to insure survival of the vegetative cover. The Mahtomedi soils are a good source of sand for construction purposes.

These soils are in capability subclass IVs. Mahtomedi part in woodland suitability group 3s and Kingsley part in woodland suitability group 2o.

896D—Mahtomedi-Kingsley complex, 12 to 25 percent slopes. This map unit consists of hilly to steep soils that are excessively drained and well drained. They are on convex ridgetops and side slopes on ground and terminal moraines. These soils are so intricately mixed that it is impractical to separate them in mapping. Mahtomedi soils make up 30 to 65 percent of the complex, and Kingsley soils make up 20 to 50 percent. Individual areas are irregular in shape and range from 2 to 30 acres.

Typically, the excessively drained Mahtomedi soils have a surface layer of very dark gray loamy sand about

5 inches thick and a brown, medium sand subsurface layer about 3 inches thick. The subsoil, about 22 inches thick, is dark brown gravelly coarse sand in the upper part and reddish brown gravelly medium sand in the lower part. The underlying material is reddish brown and light reddish brown stratified gravelly sand. In some areas the underlying material is gravelly or the surface layer is thicker and loamy.

Typically, the well drained Kingsley soils have a surface layer of dark gray sandy loam about 3 inches thick and a grayish brown sandy loam subsurface layer about 12 inches thick. The subsoil is dark brown and reddish brown sandy loam about 26 inches thick, and the underlying material is reddish brown sandy loam. In some areas the subsoil is loam.

Included with this unit in mapping are areas of Demontreville, Santiago, Ronneby, and Poskin soils. Demontreville soils have a sand mantle of glacial outwash underlain by glacial till. Santiago soils have a silty surface layer and are underlain by glacial till. Somewhat poorly drained Ronneby and Poskin soils are in small depressions. Also included, on Mississippi River bluffs in southeastern Ramsey County, are well drained loamy soils underlain by bedrock within a depth of 40 inches.

Permeability is rapid in the Mahtomedi soils and moderately slow in the Kingsley soils. Surface runoff is rapid to very rapid from both soils. The available water capacity is very low in the Mahtomedi soils and moderate in the Kingsley soils. Mahtomedi soils have low natural fertility and low organic-matter content.

Most soils in this complex are used for permanent pasture or woodland. They have poor potential for cultivated crops and have fair potential for woodland and pasture. Potential is fair for building site development and poor for sanitary facilities.

The soils in this complex generally are not suited to crops because of steep slopes, the severe hazard of erosion, and low available water capacity. They are too shallow to sand and gravel and slopes generally are too short and steep for stripcropping or contouring.

Although the use of these soils for pasture or hay crops is effective in controlling erosion, plant growth is low because the available water capacity is low. Proper stocking rates, rotation grazing, weed control, and fertilization will prevent weeds and the less desirable plant species from invading the pasture. Overgrazed pastures can be helped by reseeding with more productive plant species. These soils can erode easily if overgrazed.

This map unit has only fair suitability for trees. Because the hazard of erosion is severe, furrow planting on the contour or planting in existing vegetation is desirable and conserves moisture. Control of competing vegetation is desirable. Grassed waterways and diversions also help prevent erosion.

The soils in this unit are suitable for building site development although they are severely limited by slope. Extensive grading, especially on the steep slopes, increases erosion and can cause sedimentation in nearby lakes and streams. Erosion needs to be controlled during construction. Excavation is relatively easy, however sidewalls constructed in the Mahtomedi soils have such poor stability that they may cave in. This problem can be reduced by using temporary retaining walls or by enlarging the trenches. Because the Mahtomedi soils are noncohesive, gullies develop easily. Increased runoff from roofs and streets can cause severe erosion. This unit has poor suitability for sanitary facilities because slopes are steep and there is a hazard of sideslope seepage. There is a hazard of pollution of ground water supplies if absorption fields are constructed on the Mahtomedi soils. Vegetation may be difficult to establish on the steeper, sandy soils in the unit. They may need a topdressing of loamy material followed by sodding.

This map unit is in capability subclass VIs. Mahtomedi part in woodland suitability group 3s and Kingsley part in woodland suitability group 3r.

896F—Mahtomedi-Kingsley complex, 25 to 40 percent slopes. This map unit consists of very steep soils that are excessively drained and well drained. They are on escarpments along hills, ridges, and valley walls. Individual areas of this complex are irregular in shape and range from about 5 to 50 acres. About 30 to 65 percent of this complex consists of Mahtomedi soils and 20 to 45 percent consists of Kingsley soils. These soils are so intricately mixed that it is impractical to separate them in mapping.

Mahtomedi soils typically have a surface layer of very dark gray loamy sand about 3 inches thick. The subsoil, about 20 inches thick, is dark brown loamy sand. The underlying material is brown stratified medium sand and gravelly coarse sand. In some mapped areas the soil has a loamy mantle, 12 to 40 inches thick, or it is more than 35 percent coarse fragments.

Kingsley soils typically have a surface layer of very dark gray sandy loam about 3 inches thick. The subsurface layer, about 8 inches thick, is dark grayish brown sandy loam. The subsoil, about 24 inches thick, is reddish brown sandy loam. The underlying material is reddish brown sandy loam till. In some areas the subsoil and underlying material are reddish brown loam.

Included with this unit in mapping are areas of Demontreville, Antigo, and Santiago soils. Demontreville soils have a sandy mantle of glacial outwash underlain by loamy glacial till. Antigo soils have a silty mantle over sand and gravel. Santiago soils have a silty mantle over loamy glacial till. Also included, in a few wet depressions, are deep, moderately well drained, silty soils. On the Mississippi River bluffs in southeastern Ramsey County are well drained loamy soils in which bedrock is within 40 inches of the surface.

Permeability is rapid in the Mahtomedi soils and moderately slow in the Kingsley soils. Surface runoff is very rapid in both. Available water capacity is very low in the Mahtomedi soils and moderate in the Kingsley soils. Organic matter content is low in the Mahtomedi soils and

moderate in the Kingsley soils. Natural fertility is low in the Mahtomedi soils and medium in the Kingsley soils.

Most areas are in native vegetation. These soils have fair potential for pasture and trees. They have poor potential for crops, sanitary facilities, and building site development.

Because of the steepness of slope and the hazards of erosion and drought, these soils are generally not suited to crops. The soils are covered with plants, because a continuous cover reduces erosion. If the soils are pastured, management that includes proper stocking and rotation grazing is desirable to maintain cover. This complex provides fair pasture in spring and fall, but production is low in the summer months because of droughtiness. Supplemental pasture may be needed. Overgrazing should be prevented because these soils erode easily if left without proper cover. Planting of warm season grasses and fertilization are desirable to insure adequate production during dry summer months.

The soils in this complex have only fair suitability for trees. Because the hazard of erosion is severe, furrow planting on the contour or planting in existing vegetation is desirable. These practices also help to conserve moisture. Grassed waterways and diversions are desirable to help prevent erosion.

This unit is poorly suited to building site development because of the very steep slopes. If it is used as building sites, the extensive grading increases the hazard of erosion and can cause sedimentation of nearby lakes and streams. Erosion needs to be controlled during construction and immediately afterward. Excavation is easy; however, sidewalls have poor stability on Mahtomedi soils. Caving of sidewalls can be prevented by using temporary retaining walls or by enlarging the trenches. If buildings are designed to fit the landscape, the natural landscape can be preserved and at the same time the amount of grading, erosion, and sedimentation can be reduced. Soils of this complex are poorly suited to sanitary facilities because of the difficulty of construction on the very steep slopes and the hazard of side slope seepage. There is also a hazard of pollution of ground water supplies if absorption fields are constructed in the Mahtomedi soils. The operation of heavy machinery is generally hampered by steep slopes. Lawns, shrubs, and trees are difficult to establish and maintain on these soils because of the steepness of slope and droughtiness. When plants are established they require frequent watering and fertilization.

This map unit in in capability subclass VIIs. Mahtomedi part in woodland suitability group 3s and Kingsley part in woodland suitability group 3r.

1013—Pits, quarry. These are miscellaneous areas that have been or are being quarried. Most areas are mined for limestone or sandstone bedrock, but Ramsey County has a quarry mined for clay to be used in making bricks. In addition to the excavated bedrock, the unit includes piles of unconsolidated materials including bedrock fragments and, in the deeper parts of some quarries, water. Areas vary greatly in relief, slope, drainage, texture, reaction, and other soil characteristics.

If the topsoil is carefully stockpiled prior to quarrying, some portions of the quarries can be reclaimed. The results of reclamation vary, depending on factors such as the nature of the original soil, drainage, slope, depth of the replaced soil, and the use of the reclaimed land.

Engineering hazards vary greatly. Hazards to development include steep slopes, shallow bedrock, drainage, and possibly ground water pollution if septic tank absorption fields are installed. Onsite investigation is recommended to determine the potential and limitations of this map unit for any proposed use.

This map unit is not assigned to any interpretative group.

1027—Udorthents, wet substratum. This map unit is made up of heterogeneous, earthy fill material that has been placed on poorly drained and very poorly drained mineral or organic soils. It provides sites for buildings, roads, recreation areas, and other uses (fig. 13). Areas range from 2 to 80 acres.

The thickness of the fill is variable, but it is more than 2 feet. The source of the fill material is also variable; it is a mixture of organic and inorganic waste from human activity and sandy, gravelly, loamy, and silty soil material. Miscellaneous earth fill makes up about 80 percent of this unit. The rest is nonsoil material, such as bricks, trash, wire, metal, boards, industrial wastes, and pieces of concrete and stones and small areas of soils that have not been significantly altered by filling.

Permeability is variable. The available water capacity is variable. In some areas that have been highly compacted, water tends to pond on the surface after heavy rainfall. Runoff and internal drainage are also variable.

Many areas of this unit are almost totally covered with buildings, asphalt, concrete, or other impervious surfaces. Many of the uncovered, nearly level areas contain only small amounts of coarse fragments and are well suited to lawns, trees, vegetable gardens, and recreational uses. Areas which contain large amounts of coarse fragments or are composed of sandy soil materials are poorly suited to these uses. Settling may be a problem in areas that are underlain with organic soil material. Preferably, the organic material should be completely removed before the depression is filled. Settling may cause maintenance problems for streets, sidewalks, and pipelines. The ease of establishing and maintaining vegetation varies depending on the properties of the fill. A detailed onsite investigation is needed to determine potentials and limitations of these areas for any proposed use.

This map unit is not assigned to any interpretative group.

1029—Pits, gravel. These are miscellaneous areas used for mining sand or gravel. They consist of excavations, stockpiles of sand and gravel, areas filled with

Figure 13.—Earthy fill material being placed on very poorly drained organic soils.

waste, and water in some pits. Individual areas range from 3 to 500 acres.

These areas can be reclaimed and used for several purposes. Reclamation usually includes extensive filling and grading. Some areas can be reclaimed for agricultural use if the topsoil was carefully stockpiled and is loamy or finer in texture. Pits could be used for disposal of kinds of refuse that would not cause ground water pollution. Some areas could be used for commercial, industrial, or residential development. Many others contain ponds and can be revegetated and used for wildlife or recreational areas. Onsite investigation is needed to determine the potentials and limitations of these areas for any proposed use.

This map unit is not assigned to any interpretative group.

1033—Udifluvents. These are somewhat poorly drained, nearly level to gently sloping soils on shorelines along lakes, rivers, and sloughs. Individual areas are often 20 to 80 feet wide, frequently are elongated in shape, and range from 5 to 40 acres in size.

These soils are extremely variable. The surface layer is usually dark colored. Sandy loam, coarse loamy sand, or coarse sand extends to a depth of 30 to 60 inches. Most areas are underlain by loam or sandy loam till.

Permeability is variable. The available water capacity is low. The seasonal high water table is within 4 feet of the surface during most seasons. During wet periods, some areas are submerged. The organic matter content and natural fertility are usually low.

Most areas are beaches used for swimming and other recreation. Potential is poor for agriculture. It is also poor for sanitary facilities and building site development.

These soils have poor potential for crops and pasture because of the low fertility and droughtiness. Plants sould be protected, because a good cover of plants is

difficult to establish. Some areas flood or pond during wet periods. If trees are planted, drought tolerant species should be used.

Udifluvents are poorly suited to sanitary facilities and building site development. A high water table and occasional flooding are hazards. Septic tank absorption fields may pollute the ground water and the nearby lakes or rivers. Many areas of these soils make excellent beaches.

This map unit is in capability subclass IVw. It is not placed in a woodland suitability group.

1039—Urban land. This miscellaneous area has more than 90 percent of the surface covered with buildings, asphalt, concrete, or other impervious surfaces. The areas generally range from 2 to more than 600 acres and are level to gently sloping. Identification of the soils in these areas is not feasible because they have been greatly altered in various ways by construction. Developments on these areas include factories, shopping centers, warehouses, railroad yards, and parking lots. Included in mapping are some small areas that have been cut or filled.

Runoff of rainwater is high and often flows into storm drainage systems. If improperly channeled, the increased runoff from nearby areas may cause severe erosion. Vegetation is generally in narrow strips along sidewalks, between roadways, and in isolated islands. Such vegetated areas total less than 5 percent of the map unit. Onsite investigation is essential to properly evaluate and plan development for specific puposes.

This map unit is not assigned to any interpretative group.

1040—Udorthents. This map unit consists mainly of nearly level to gently sloping areas where the natural soil has been removed or covered with other material. These areas consists mostly of reclaimed gravel pits and borrow pits. They are mostly well drained or moderately well drained. Individual areas range from 3 to 150 acres.

The surface layer and the underlying material are quite variable in depth and composition. In some areas the original surface layer has been removed, exposing loamy alluvium or glacial till. Included in mapping are areas that have steeper slopes.

The soil materials in this map unit have a wide range in permeability and other soil properties.

Udorthents are farmed as a part of larger fields or are left idle. Due to the wide range in soil characteristics and behavior, onsite investigation and soil borings are needed to determine the potential for any use.

In some places this unit has been developed as building sites. Onsite investigation is needed to determine its suitability for this use. Where it has been used for landfills, natural gas resulting from decomposition of the buried refuse is a hazard to building. Also, because of the various kinds of materials used for fill, some areas are subject to subsidence. Depth of the seasonal high water table and the possible pollution of underground water supplies are other potential hazards which need to be considered during onsite investigations.

This map unit is not assigned to any interpretative group.

1055—Aquolls and Histosols, ponded. This map unit consists of level, very poorly drained mineral and organic soils around lakes or rivers and in depressions of till plains and outwash plains. Some areas are dry late in summer or during periods of drought, but most areas are continuously ponded. An individual area may consist of only Aquolls or Histosols, or it may have both. Most mapped areas have a dense growth of water-tolerant vegetation and small areas of open water.

Because the water table is high and there is a lack of suitable outlets, this map unit has poor potential for crops, pasture, woodland, and community development. However, it has good potential for food and cover for wetland wildlife.

This map unit provides nesting, mating, and escape areas for waterfowl, furbearers, and upland game. Many of these areas can be improved for wildlife production by controlling the water level, by increasing nesting and courting areas for ducks, and by fencing out livestock.

Many of these areas are impractical to drain because of the proximity of nearby streams or lakes. However, if suitable outlets are available, this unit can be drained. Areas to be drained need preliminary onsite investigation of the nature and thickness of the soil material. This investigation helps determine what management or engineering practices are needed and whether drainage is feasible.

This map unit is in capability subclass VIIIw.

1813B—Lino Variant loamy fine sand, 2 to 6 percent slopes. This gently sloping soil is moderately well drained. It occurs adjacent to side slopes of drainageways, on slightly elevated flats and knolls, and on outwash plains and lake plains. Individual areas are irregular in shape and range from 3 to 20 acres.

Typically, this soil has a very dark grayish brown loamy fine sand surface layer about 7 inches thick. The subsoil, to a depth of more than 60 inches, is stratified dark yellowish brown to pale brown fine sand. It has thin dark brown loamy fine sand bands in the lower part. Yellowish brown and brownish yellow mottles occur below a depth of 28 inches.

Included in mapping are small areas of excessively drained Zimmerman soils in steeper, convex positions and small areas of somewhat poorly drained Lino and very poorly drained Isanti soils in drainageways and small depressions.

Permeability of this Lino Variant soil is rapid, and surface runoff is slow. The available water capacity, organic matter content, and natural fertility are low. A seasonal high water table occurs at a depth of 4 to 6 feet in undrained areas.

Most areas of this soil are farmed. This soil has fair potential for all the common crops grown in the survey area. It has fair potential for woodland and pasture. It has poor potential for sanitary facilities and fair potential as building sites.

This soil has fair suitability for most crops grown in the survey area. The surface layer is friable and easily tilled. It warms early in spring and dries soon after rains. Yields commonly are low. Because of the low available water capacity, early maturing crops, such as small grains, usually make best use of spring soil moisture. Irrigation is desirable on nearly level fields. This soil is subject to soil blowing, and young plants are often damaged by blowing sand. Soil blowing can be controlled by keeping the soil covered with plants over winter and by using minimum tillage. Additions of organic matter improve fertility and tilth and increase the available water capacity. Crops respond to small or moderate amounts of fertilizer unless the soil is irrigated or rainfall is timely.

This soil has fair suitability for pasture but is limited by low natural fertility and low available water capacity. Pasture production is fair in the spring and fall but is low during the summer months. Supplemental pasture may be needed during dry summer months. Keeping this soil under continuous grass reduces the hazard of soil blowing.

This soil has fair suitability for trees. Droughtiness and low natural fertility are major factors contributing to the moderate seedling mortality rate. Special care must be taken to minimize soil loss and damage to seedlings by blowing sand. Drought resistant trees are best suited to this soil.

This soil has fair suitability for building site development. Susceptibility to frost heave is moderate and needs to be considered in the design of roads and streets. Sidewalls of shallow excavations have poor stability and may cave in during excavation or installation of underground utilities. This can be prevented with temporary retaining walls. Because of the seasonal high water table, it is good practice to install drain tile around footings of foundations to prevent wet basements. A good drain tile outlet is needed. Septic tank absorption fields are limited by the seasonal high water table and the hazard of pollution of ground water supplies by seepage of effluent through the porous sand material. The absorption field should be specially designed to overcome these limitations. Lawns, trees, and shrubs are difficult to establish and maintain on this soil. Frequent watering and fertilizing along with a topdressing of loamy material before seeding are necessary to maintain vigorous growth.

This soil is in capability subclass IIIs and woodland suitability group 3s.

1819F—Dorerton-Rock outcrop complex, 25 to 65 percent slopes. This complex consists of very steep, well drained soils and Rock outcrop on stream valley side slopes. It is 50 to 75 percent Dorerton soils and 15 to 20 percent Rock outcrop. The Dorerton soils are on plane to slightly concave, mid and lower back slopes. The Rock outcrop is exposed near the shoulder slopes and on upper back slopes. The areas of Rock outcrop are so intricately mixed with the Dorerton soils or so small in extent that it is not practical to separate them in mapping. Individual areas of this complex range from 30 to 120 acres.

Typically, the Dorerton soil has a surface layer of very dark gray sandy loam about 4 inches thick over a fine sandy loam dark brown subsurface layer about 6 inches thick. The subsoil is about 12 inches thick. It is dark brown gravelly clay loam in the upper part and dark brown flaggy clay loam in the lower part. The underlying material is pale brown flaggy loamy sand. Limestone bedrock underlies the soil at a depth of 45 to 70 inches. In some areas the surface layer is darker colored.

Typically, the Rock outcrop consists of limestone bedrock 2 to 4 feet high and 10 to 50 feet long. In some places sandstone bedrock is exposed on lower foot slopes.

Included in mapping are areas of clayey soils developed from shale bedrock. These soils are on the upper back slopes and summits along the Mississippi River north of the Ford Parkway Bridge in Ramsey County.

Permeability of the Dorerton soil is moderate and moderately rapid. The available water capacity is moderate, organic matter content is low, and natural fertility is medium. Surface runoff is rapid. The rooting depth is restricted by the highly fractured limestone.

Most areas of this complex remain in native hardwoods and are used primarily for scenic purposes. The Dorerton soil has poor potential for hay, pasture, and for sanitary facilities and building site development.

Areas used for woodland wildlife should be managed to protect existing habitat and to maintain or improved its quality. Management for wildlife habitat also serves to enhance these areas for scenic purposes.

Mainly because of the very steep slopes, the soil in this complex is poorly suited to sanitary facilities and as building sites. Also, in making shallow excavations for basements or other purposes, hard bedrock is encountered. If buildings are constructed, they should be designed to fit the site and preserve the natural landscape while reducing the need for grading and reducing erosion and sedimentation.

This complex is in capability subclass VIIe and woodland suitability group 3f.

1820F—Mahtomedi Variant-Rock outcrop complex, 25 to 60 percent slopes. This complex consists of very steep, excessively drained soils and Rock outcrop on stream valley side slopes. Individual areas are 40 to 75 percent Mahtomedi Variant soils and 10 to 30 percent Rock outcrop. The Mahtomedi Variant soils are on plane to slightly concave, mid and lower back slopes. The Rock outcrop is exposed near shoulder slopes and on upper back slopes. Areas of soil are so intricately mixed

or so small in extent that it is not practical to map them separately. Individual areas of this complex range from 30 to 120 acres in size.

Typically, the Mahtomedi Variant soils have a very dark gray sandy loam surface layer about 3 inches thick. The subsoil is about 39 inches thick. The upper part is reddish brown grading to brown and dark brown loamy sand. The lower part is yellowish brown sand. Light brownish gray sandstone is at a depth of 42 inches. In places, the profile formed entirely in material weathered from sandstone bedrock.

Typically, the Rock outcrop consists of sandstone bedrock 2 to 10 feet high. It ranges to as much as 75 feet high and 10 to 100 feet long. In some places there are shattered fragments of sandstone, 1 to 2 feet high and 2 to 6 feet in diameter, that have been moved downslope by gravity.

Included in mapping are areas of a soil that is similar to the Dorerton soils but is underlain by sandstone bedrock. They are on plane to slightly concave upper back slopes. Also included are areas of less steep Copaston soils. Seep areas are in some delineations. These inclusions make up less than 5 percent of the mapped area.

Permeability is rapid in the Mahtomedi Variant soils. The available water capacity is low. Surface runoff is rapid. Natural fertility and organic matter content are low. Depth to bedrock is 40 to 80 inches.

Most areas of this complex remain in native hardwood forests and are used for scenic purposes and as habitat for woodland wildlife. Potential is fair for woodland wildlife habitat. It is poor for crops or pasture. It is poor for building site development and sanitary facilities.

Steep slopes and droughtiness are the limiting factors. Areas used for woodland wildlife habitat should be managed to protect existing habitat and maintain or improve its quality. Management for wildlife also serves to enhance these areas for scenic purposes.

This complex is in capability subclass VIIs and woodland suitability group 4s.

1821—Algansee loamy sand. This soil is nearly level, somewhat poorly drained, and very rapidly permeable. It is on the flood plains of major rivers. Individual areas vary in shape and range from 20 to 100 acres. This soil is occasionally flooded by stream overflow.

The surface layer is very dark gray loamy sand about 6 inches thick. The underlying material is multicolored brownish sand which has faint yellowish brown mottles. In some places the soil contains thin layers of loam or sandy loam. Also, some profiles have gravelly layers below a depth of 40 inches.

Included with this soil in mapping are small areas of Chaska loam. This is a poorly drained soil in shallow depressions. It makes up less than 5 percent of the mapped area.

This Algansee soil has very rapid permeability and slow surface runoff. The natural fertility and organic matter content are low. This soil has low available water capacity. A seasonal high water table is at a depth of 1 to 3 feet.

Most of this soil is used for pasture, forest, or for parks and recreation areas (fig. 14). The hazard of flooding limits the use of this soil. This soil has fair potential for crops, pasture, hay, and woodland. It has poor potential for sanitary facilities and building site development. It has fair potential for recreational uses or wildlife sanctuaries.

When this soil is cropped, the low available water capacity, soil blowing, and seasonal flooding are the main concerns of management. Early maturing crops, such as small grains, make best use of the early spring moisture. Minimum tillage or maintaining a cover of crop residues will reduce soil blowing. It is difficult, however, to keep a good vegetative cover on this soil. The production of pasture is low during dry summer months. Overgrazing should be avoided because this soil blows easily.

This soil has fair suitability for trees. Growth is limited by low fertility and the low available water capacity. Seedling mortality is moderate to severe, and survival of seedlings depends on timely rainfall. Seedlings are subject to damage from soil blowing. Planting trees in furrows reduces soil blowing and conserves moisture. Site preparation is necessary to control competing vegetation.

This soil is poorly suited to building site development because of wetness and flooding. If buildings must be constructed on this soil, tile drains should be used or the foundations should be constructed above the water table. Septic tank absorption fields function poorly because of the high water table, and they may pollute the ground water and nearby lakes or streams. Streets, driveways, and parking lots are subject to cracking unless properly designed. Because excavations and trenches are subject to collapsing, temporary retaining walls should be used. Lawns are difficult to establish on this soil.

This soil can be used for parks, recreation areas, and wildlife sanctuaries. Areas that are less seldom flooded are suitable for campsites and picnic areas because the period of peak use generally occurs after floodwaters have receded.

This soil is in capability subclass IIIw and woodland suitability group 3s.

1827—Waukegan Variant silt loam, 0 to 2 percent slopes. This level soil is well drained and is on uplands and terraces. It formed in 20 to 30 inches of loess over 10 to 20 inches of sandy glacial outwash and is underlain by limestone bedrock at a depth of 30 to 45 inches. Individual areas are irregular in shape and range from 5 to 20 acres.

Typically, ths surface layer is very dark grayish brown silt loam about 12 inches thick. The subsoil is about 28 inches thick. The upper part is dark brown silt loam. The lower part is yellowish brown fine sand grading to brown

Figure 14.—Pasture on Algansee loamy sand. Brodale soils are on the steep slopes on the left, Antigo soils on uplands to the right.

gravelly sand. It is underlain by limestone bedrock. In some areas the part of the subsoil that formed in outwash material has redder colors. In a few areas a thin layer of residuum occurs between the silty mantle and the limestone bedrock. Small areas with slope of more than 2 percent are in some delineations.

Included with this soil in mapping are small areas of Waukegan, Antigo, and Ripon soils. Waukegan and Antigo soils do not have limestone bedrock within a depth of 30 to 50 inches. Ripon soils do not have sandy outwash as part of the subsoil. Outcrops of limestone bedrock are in some mapped areas.

This Waukegan Variant has moderate permeability in the silty mantle and rapid permeability in the sandy outwash. Surface runoff is very slow. Available water capacity is moderate. Natural fertility is medium, and the organic matter content is moderate.

Most areas of this soil are farmed. This soil has fair potential for all the common crops grown in the survey area. It has poor potential for sanitary facilities and fair potential as building sites.

This soil has fair suitability for corn, soybeans, small grains, and forages. In drier years droughtiness may be a problem because the available water capacity is only moderate. Minimum tillage, crop rotation, and return of crop residues to the soil improve fertility, increase water infiltration, and increase organic matter content. This soil is suited to irrigation.

This soil has fair suitability for pasture and hay. Productivity of all forages is good. Proper stocking, rotation grazing, fertilization, and weed control help to keep the pasture and soil in good grazing condition. Droughtiness is a problem during the summer months due to the low water holding capacity in the outwash. Planting pasture and hay may be desirable to improve plant species and potential yield.

This soil has fair suitability as building sites. The depth to rock is the main limitation. In most areas the underly-

ing bedrock is very hard or cemented and requires large machinery for excavation. This soil is poorly suited to septic tank absorption fields because it is shallow to the underlying bedrock. There is a hazard of effluent seeping into the ground water through cracks in the bedrock unless specially designed systems are installed. Lawns, trees, and shrubs are generally easy to establish but may need additional watering during dry periods.

This soil is in capability subclass IIs. It is not placed in a woodland suitability group.

1827B—Waukegan Variant silt loam, 2 to 9 percent slopes. This gently sloping and moderately sloping soil is well drained and is on uplands and terraces. It formed in 20 to 30 inches of loess over 10 to 20 inches of sandy glacial outwash and is underlain by limestone bedrock at a depth of 30 to 45 inches. Individual areas are irregular in shape and range from 5 to 15 acres.

Typically, the surface layer is very dark grayish brown silt loam about 12 inches thick. The subsoil is about 28 inches thick. The upper part is dark brown silt loam. The lower part is brown and yellowish brown fine sand and gravelly sand. It is underlain by limestone bedrock. In a few areas a thin layer of residuum occurs between the silty mantle and the limestone bedrock. Small areas with slope of less than 2 percent or more than 9 percent are in some delineations.

Included with this soil in mapping are areas of Waukegan, Antigo, and Ripon soils. Waukegan and Antigo soils do not have limestone bedrock within a depth of 30 to 50 inches. Ripon soils do not have sandy outwash as part of the subsoil. Outcrops of limestone bedrock are in some map units.

This Waukegan Variant has moderate permeability in the silty mantle and rapid permeability in the sandy outwash. Surface runoff is medium. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate.

Most areas of this soil are farmed. This soil has fair potential for all the common crops grown in the survey area. It has fair potential as building sites and poor potential for sanitary facilities.

This soil has fair suitability for corn, soybeans, small grains, and forages. In drier years droughtiness may be a problem because of the moderate available water capacity. Minimum tillage, crop rotation, and the return of crop residues to the soil improve fertility, increase water infiltration, and increase organic matter content. There is a hazard of erosion on the stronger slopes, where contour stripcropping or mulch tillage should be used.

This soil has fair suitability for pasture and hay. Productivity of all forages is good. Proper stocking, rotation grazing, fertilization, and weed control help to keep the pasture and soil in good condition. Droughtiness is a problem during summer months due to the moderate available water capacity. Overgrazing should be avoided because it increases the risk of erosion.

This soil has fair suitability as building sites. The depth to rock is the main limitation. In most areas the underlying bedrock is very hard or cemented and requires large machinery for excavation. Erosion needs to be controlled during construction. This soil is poorly suited to septic tank absorption fields because it is shallow to bedrock. There is a hazard of pollution of ground water by seepage of effluent through the cracks in the bedrock unless specially designed systems are installed. Lawns, trees, and shrubs are generally easy to establish but may need additional watering during dry periods. Trafficability is poor when the upper silty material is wet. Erosion needs to be controlled during construction.

This soil is in capability subclass IIe. It is not placed in a woodland suitability group.

1847—Barronett silt loam, sandy substratum. This is a nearly level, poorly drained soil. It occupies plane or slightly concave positions in depressions and drainageways on outwash plains. Individual areas are irregular in shape and range from 2 to 15 acres. This soil is subject to frequent flooding by runoff from adjacent more sloping soils.

Typically, the surface layer is black silt loam about 17 inches thick. The subsoil is light olive gray, mottled silt loam about 25 inches thick. The upper part of the underlying material is light olive gray loamy sand. The lower part of the underlying material is brown sand and some gravel. In some areas the silt mantle is more than 60 inches thick.

Included in some delineations are small areas of Poskin, Brill, and Markey soils. The Brill soils are moderately well drained and occupy slightly higher positions on the landscape. The Poskin soils are somewhat poorly drained and are also in slightly higher positions. The Markey soils are very poorly drained and formed in muck underlain by outwash.

Permeability of this Barronett soil is moderately slow in the silty mantle and very rapid in the underlying material. Surface fertility is medium, and organic matter content is high. A seasonal high water table occurs at a depth of less than 1 foot.

Most areas of this soil are in pasture or woodlots. It has good potential for crops, pasture, or hay. It has fair potential for woodland. It has poor potential for sanitary facilities and building site development.

This soil has good potential for crops if properly drained and managed. Because good outlets are lacking in many areas, tile drainage is not feasible. In some places surface ditches can be used to lower the water table. Corn, soybeans, and hay are the principle crops. Practices that increase the movement of air and water into and through the soil and that return large amounts of crop residue to the soil are needed. Applying manure, growing grasses and legumes, and fertilizing properly are ways of maintaining tilth and fertility and improving drainage. This soil is generally plowed in fall, which enables frost action over winter to break the clods and produce a good spring seedbed.

The suitability of this soil for pasture is fair. During spring it is generally too wet for grazing. Proper stocking,

pasture rotation, timely deferment of grazing, and restricted use during wet periods will help keep the pasture and soil in the best condition. Pasture can be improved by drainage and seeding.

This soil has fair suitability for trees. The root zone is restricted by the coarse textured underlying material and seasonal high water table. Plant competition is severe. Seedlings survive and grow well if competing vegetation is controlled or removed. Seedling mortality is moderate. Equipment limitations are severe.

This soil is poorly suited to building site development because of wetness and flooding. Basements will be wet unless the water table is lowered or the foundation is placed above the water table. This soil is highly susceptible to frost heave. Streets, driveways, and parking lots are subject to heaving and cracking unless carefully designed. The silty mantle has low strength, and moderate volume changes occur with changes in soil moisture. The underlying material generally has good strength for supporting low buildings.

This soil is poorly suited to septic tank absorption fields because of wetness and flooding. The pollution of nearby wells, streams, and lakes is a hazard because the underlying material has rapid permeability. This soil is a good source of sand for construction, but the depth of excavation is limited by the seasonal high water table. Trees, shrubs, and grasses are fairly easy to establish if the water table level is controlled.

This soil is in capability subclass IIw and woodland suitability group 3w.

1848B—Sparta loamy sand, bedrock substratum, 0 to 6 percent slopes. This level to gently sloping soil is excessively drained. It occurs on bedrock-cored outwash terraces of major rivers. The bedrock is at a depth of 40 to 60 inches. Individual areas range from 10 to 80 acres and are irregular in shape.

Typically, the surface layer is black loamy sand about 5 inches thick. The subsoil is dark brown fine sand about 35 inches thick. The underlying material is dark reddish brown clay loam about 4 inches thick. Limestone bedrock is at a depth of 44 inches. In some areas no bedrock is within 60 inches. In some areas the sandy mantle is less than 40 inches thick. In some areas slope is more than 6 percent.

Included in mapping are small areas of Dickman and Hubbard soils. Dickman soils have a sandy loam surface layer and subsoil and have no bedrock within 60 inches. Hubbard soils contain medium and coarse sand and fine gravel and also lack bedrock within 60 inches.

Permeability of the Sparta soil is rapid in the sandy mantle. Natural fertility, organic matter content, and available water capacity are low.

Most areas of this soil are cultivated. This soil has poor potential for row crops and fair potential for grains or forage crops. It has good potential as building sites and poor potential for sanitary facilities.

This soil is poorly suited to corn and soybeans. The low available water capacity and low natural fertility are the major limiting factors. Early-maturing crops are best suited to this soil because they are not affected by the late-season drought. Management that increases organic matter content will increase the water holding capacity of the soil. This soil is well suited to irrigation, if an adequate water supply is available. A proper fertilization program is needed to offset the low natural fertility. Soil blowing is a problem, and young plants are easily damaged by blowing sand. Minimum tillage, cover crops, and field windbreaks reduce soil blowing and conserve moisture.

This soil has fair suitability for pasture and hay. It is limited by low available water capacity and low natural fertility. Production of pasture is fair in spring but is low during summer months when supplemental pastures may be needed. Where planting is necessary to improve stands and potential yield, more drought resistant species are desirable.

This soil is well suited to building site development. It is poorly suited for sanitary facilities. Shallow excavations are relatively easy to make in the upper part of the profile; but sidewalls have poor stability and may cave in. This problem can be overcome by overexcavation or by installing temporary retaining walls. The bedrock is hard enough that large machinery is needed for excavation. Septic tank absorption fields are poorly suited to this soil because of the depth to bedrock and the hazard of pollution of ground water. Lawns, trees, and shrubs are difficult to establish and maintain on this soil. Topdressing with 12 to 18 inches of loamy material is desirable before laying sod or seeding grass. Frequent watering and fertilizing are necessary to maintain vigorous sod.

This soil is in capability subclass IVs. It is not placed in a woodland suitability group.

Use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops, pasture, and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and pasture

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

Some basic management practices are needed for almost all of the soils that are used for crops and pasture. The following paragraphs discuss basic practices needed for controlling erosion, providing drainage, preserving tilth, maintaining fertility, conserving moisture, and irrigating. Technical assistance in planning and applying practices suitable for the soils on a particular farm can be obtained from a local representative of the Soil Conservation Service.

Erosion control. Water erosion is a hazard on the sloping soils. To control water erosion, it is necessary to reduce runoff and increase the water intake. This can be done by contour cultivation, terracing, stripcropping, minimum tillage, grassed waterways, and proper use of crop residue. A high content of organic matter and high level of fertility increase the infiltration of water and enable the soil to support crops that improve the soil structure.

Soil blowing occurs throughout the survey area but is less serious than the water erosion. It is more serious on the sandy soils in the northeast and southeast parts of the survey area than on other soils. It can, however, be controlled by maintaining a cover of plants or crop residue and by conservation tillage, stripcropping, wind stripcropping, and the use of field windbreaks to protect exposed areas. Areas subject to soil blowing need a cropping system that provides a cover of residue in winter and early in spring when soil blowing is most likely to occur.

Drainage. Drainage is needed for intensive cropping of wet, level, or depressional soils. Tile drains work in some areas, and surface ditches may be adequate to remove surface water in others. In areas that are underlain by sandy or gravelly material, however, it is difficult to install tile and to maintain open drains.

Root development is good in soils that are adequately drained because the movement of air and water into the soil is not restricted. Soils that are adequately drained generally warm up earlier in spring than other soils. Effective drainage permits more timely field operations than are possible in undrained areas.

Tillage. Frequent tillage or tilling when the soils are too wet or too dry damages the structure of the soils. Frequent tillage makes the surface layer powdery so that water is not absorbed readily. This tends to increase the amount of runoff, thereby limiting the amount of moisture available to plants and increasing the hazard of erosion. Tilling when the soil is too wet makes the surface layer cloddy and undesirable as a seedbed. Tillage should be restricted to the amount required to prepare a good seedbed, to control the growth of weeds, and to control the volunteer growth of crops from the previous year. Tillage can be further reduced if chemicals are applied to control weeds and if machinery is used that provides only minimum tillage.

Fall plowing is a common practice. Tillage other than rough plowing should be avoided in fall. A rough surface holds the moisture from melting snow and reduces the hazard of erosion. Freezing and thawing in winter helps break the clods and make tillage easier in the spring. Soils plowed in the fall can be tilled earlier in spring than soils not fall plowed. As a result, a better seedbed is generally prepared and the potential for a good stand of plants is increased.

Sloping soils can be protected from excessive soil loss by using minimum tillage and by properly managing all crop residue. These practices help to control erosion and provide a better seedbed. Wherever possible, sloping soils should be cultivated on the contour. Fall plowing is suitable if such soils are terraced and if manure or some other protective mulch is used.

Fertilization. The soils in Washington and Ramsey Counties vary widely in their need for lime and fertilizer. It depends on the natural acidity of the soil, the previous management, and the cropping system that is planned. The soils should be tested once during the cropping system, or about every 3 to 5 years, to determine the need for lime and fertilizer. Tests should be conducted by a reliable laboratory which provides an analysis and interprets the results.

Moisture conservation. Droughty, sandy soils need practices that conserve moisture. This generally means

controlling wind erosion, limiting runoff, increasing water infiltration, and controlling weeds. Methods that help are field windbreaks, stripcropping, minimum tillage, maximum use of crop residue, and planting early-maturing crops.

Irrigation. Approximately 3,200 acres of this survey area are irrigated. Wells are the primary source of irrigation water. Factors to be considered when planning an irrigation system are the soil type, amount and quality of water needed, type of irrigation system needed, and the preparation and drainage and overall management of the land. Good management requires a knowledge of water application—the amount, when to apply it, and how to distribute it evenly. Also, most soils need to be fertilized if crops are to benefit fully from irrigation. Help in planning an irrigation system can be obtained from local offices of the Soil Conservation Service, the Agricultural Extension Service of the University of Minnesota, and local irrigation system dealers.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

Land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Soil maps for detailed planning."

Woodland management and productivity

Washington and Ramsey Counties are within the northern deciduous forest region and were primarily covered with forest types of northern upland hardwoods and oak. Native species are quaking aspen, Northern red oak, white oak, sugar maple, American elm, American basswood, and black cherry. In the northern part of Washington County, aspen-oak forests predominated.

Originally the counties were forested except for two grassland areas. The largest of these areas was in south-central Washington County. The other was on the Lakeland terrace in east-central Washington County. Even here, there were scattered tracts of timber, consisting mainly of oak and elm.

The river-bottom hardwood forest type is along the flood plains of the Mississippi River and the upper St. Croix River. The forest consists of eastern cottonwood, black ash, green ash, American elm, willow, and hackberry.

Large areas of very poorly drained organic soils were treeless except for scattered tamarack, black ash, and eastern white-cedar. Most of such areas were dominated by sedges and water-tolerant grasses.

The woodland in the survey area is now in small tracts. Tree species are similar to the original forest types. Wood production is limited. Many areas are used for homesites and recreation, and some are grazed.

Table 6 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 6, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

Windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

Recreation

The many lakes and streams, the wooded hills, and the picturesque scenery in Washington and Ramsey Counties provide ample opportunity for recreational development. Ideal picnic areas, campsites, and scenic overlooks occur along the major rivers in the county. Numerous sites commemorating events in early Minnesota history are in both counties. The many lakes in the survey area are used for boating, swimming, and fishing. Numerous county and city parks provide picnic areas, hiking trails, biking trails, swimming beaches, and other recreational facilities. The William O'Brien, Fort Snelling, and Afton state parks offer a wide range of recreational facilities from camping and picnic areas to cross-country skiing and snowmobile trails. Some of the rolling hills throughout the survey area are well suited to development of ski and toboggan runs. Afton Alps is known for excellent skiing facilities. Because city dwellers in increasing numbers are turning to outdoor recreation, the owners of farms, woodlands, and lakeshores have an opportunity to develop new and potentially profitable facilities for camping, hiking, skiing, fishing, hunting, golfing, and other forms of outdoor recreation.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife

By George L. Pollard, biologist, Soil Conservation Service, St. Paul, Minnesota.

The soils of Washington and Ramsey Counties have the potential to provide good habitat for various kinds and species of wildlife. These counties are in the transitional area for several major wildlife species. The number of animals of any one species may not be as high as in

more favored areas within the animal's range. In most of Ramsey County and in scattered areas of Washington County, the natural habitat of many species of wildlife has been changed or destroyed by urbanization.

The principal wildlife in Washington and Ramsey Counties are several species of migratory waterfowl; mink, muskrat, and other small furbearing animals that inhabit water areas; grouse, pheasant, and other upland game birds; rabbits, fox, squirrel, and other small mammals; and deer.

Many of the lakes in the survey area, mainly White Bear, Big Marine, Lake Elmo, and Forest Lakes, provide good fishing. The principal sport fish are northern pike and such pan fish as bluegill, crappie, and sunfish. The St. Croix River provides good fishing for walleye, bass, crappies, and catfish.

Wildlife populations can be increased by using such conservation measures as rotating crops, planting crops in strips, and seeding ditchbanks and field borders to provide a variety of cover that is attractive and beneficial to wildlife. Improving farmstead windbreaks and planting odd areas with grasses, legumes, shrubs, and trees will provide food and cover for many species of wildlife.

Scattered about the rapidly urbanizing parts of Washington and Ramsey Counties are soil areas that are left undeveloped because of severe limitations to urban uses. These areas produce and shelter large numbers of waterfowl and pheasants which are protected by local ordinances.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, soybeans, wheat, oats, barley, and millet.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, switchgrass, timothy, clover, trefoil, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, indiangrass, goldenrod, beggarweed, smartweed, sweetclover, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, crabapple, plum, cherry, honeysuckle, and caragana.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are

created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include pheasant, meadowlark, field sparrow, cottontail, red fox, and woodchuck.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and white-tailed deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building site development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone

content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Landscaping and gardening

Table 10 lists the suitability of each map unit in the survey area for lawns and landscaping. This information should be supplemented by consulting local nurserymen, horticulturists, landscape architects, extension agents, representatives of the Soil Conservation Service, or library references in selecting vines and ground covers, shrubs, trees, and grasses and legumes that are suitable for the anticipated uses. The 1972 U.S. Department of Agriculture Yearbook (*6*) covers many aspects of landscaping in urban areas. For example, it describes the effects of heat from pavements, salts, shade, and microclimates of individual yards. This book is available in most public libraries.

The suitabilities and limitations listed in table 10 are for undisturbed soils. Many of the soils in Washington and Ramsey Counties have been disturbed to some degree during excavation for utilities and foundations for buildings and during construction of roads and walks. This is especially true of soils in Urban land complexes. Climatically adapted plant species will ordinarily do well on specific soils unless the soil has been severely altered, physically or chemically. The closer the soil is to a manmade object, the more likely this is to have happened. For instance, wood, brick, gypsum board, metal stripping, mortar, and other artifacts are commonly thrown or dumped around the foundation of a building while it is under construction. These items later find their way into the backfill around the foundation. For this reason, an onsite investigation including a soil reaction (pH) test, should be made before planting around foundations or other areas that may have been severely disturbed.

SELECTING PLANT MATERIALS

The following factors, in addition to those already mentioned, need to be considered before plant materials for landscaping are selected.

Shade. Any map unit that is dominantly Urban land has a high density of buildings. What little soil is available between or around the buildings may be in the shade much of the day. Soils areas most subject to shade are by their very nature close to foundations and were subject to physical and chemical disturbance during construction. In the Urban land complexes, careful observation of shade patterns and chemical analysis of the soils are needed before plants are chosen. Lime is seldom needed in shaded areas because practically all shade-loving plants thrive in an acid soil. Regardless of the kind of soil indicated by the soil map, additions of peat moss, humus, or compost in and on the surface will benefit shade-tolerant plant species.

Wetness. Not many plants thrive in wet soils. Some things can be done to overcome the wetness. One is to install subsurface drainage, if the soil is permeable enough for excess water to move through it. Another is to bring in new soil and use raised beds to get a satisfactory rooting zone. In other places, the problem may be runoff from adjacent slopes accumulating as ponded water on low-lying plantings. In urban areas, alleviating wetness is often difficult because of property line restrictions that limit alternative solutions. With the consent of neighbors and advice from a specialist, the problem may be solved.

Restricted root zone. Generally, soils with a restricted root zone do not hold enough moisture for plants throughout the growing season. In urban areas there may be many such restrictions. Investigation may disclose impermeable barriers such as chunks of asphalt or

concrete covered by grading or filling. If any soil in the Brodale, Channahon, Copaston, Dorerton, Ripon, Waukegan Variant, or Whalan series has been severely graded during construction, the hard underlying limestone bedrock may have been exposed or left within a few inches of the surface. Shrubs, lawns, trees, and gardens planted in such soils are likely to do poorly. Where root-restricting layers are near the surface, the root zone can be thickened by adding topsoil and by mixing as much organic matter as possible into the original soil. This will also increase the moisture holding capacity of the soil.

Compaction. A noncompacted soil that has good structure is about 50 percent actual mineral soil and 50 percent pore space. When the soil is in good condition for digging, about half of the pore space is filled with water. Therefore, most tilling is done when the soil is about 50 percent mineral solids (soil), 25 percent air, and 25 percent water. In a highly compacted soil, the pore space has been greatly reduced by the weight of machinery or foot traffic forcing mineral soil solids into the pore space. As a result, the soil holds less air and water and is less permeable than normal.

Any soil that is either naturally compact or has been mechanically compacted provides a very poor environment for roots, which results in poor performance of the plant above ground. Mechanically compacted soils are extensive in Urban land complexes. These compacted soils resist root penetration, absorb little if any rainfall, and cause excessive runoff. Every effort should be made to incorporate organic matter in at least the upper 12 inches of a compacted soil. Planting legumes also helps to break up the compacted soil.

Salt pollution. Salts occur naturally in soils and water and may be considered pollutants only when man introduces extraneous salts—as when salt is used to de-ice walks, driveways, city streets, and highways (*3, 4*). These salts can injure plants. Salt injury should be suspected whenever a planting is within splash distance of streets and gutters or is where runoff from driveways and walks flows onto or over the planted areas. Salt concentration in water draining off highways and streets can be so high that no plant adapted to the area may be able to survive. Most shrubs are moderately tolerant of salt. Among trees, honey locust is salt-tolerant. Blue spruce and white pine are relatively sensitive to salt, but hackberry, eastern redcedar, white oak, red oak, spreading juniper, and arborvitae are moderately tolerant of it.

If salt injury is suspected, leaching the soil is one way of reducing the salt concentration to below the injurious level. Leaching consists of applying more water to the planted area than can evaporate or be used by the plant. If the excess water can drain away below the roots, it will carry with it the excess, unwanted salts. In order for this to be effective, the soil must have good internal drainage and must not be severely compacted.

Air pollution. Air pollution can seriously damage many ornamentals. Two of the most pernicious pollutants are ozone and peroxyacetyl nitrate (PAN), both of which are photochemical pollutants. Oxides of nitrogen in the air, in the presence of sunlight, react with oxygen to form ozone. Similarly, PAN is formed in sunlight by the chemical combination of nitrogen oxide with hydrocarbon in the atmosphere. As a general rule, small-leaved plants are more resistant to air pollutants than are large-leaved plants. Also, slow growing plants are more resistant than rapidly growing plants that have more soft tissue.

Because air pollution affects the plant more than it affects the soil, it cannot be directly correlated with kinds of soil. This section is simply to alert the reader that air pollution is a possible explanation for plant damage.

FLOWER AND VEGETABLE GARDENS

In this section the characteristics of good garden soil are discussed, as well as characteristics that make a soil undesirable for gardening. The basic requirement for gardens is a nearly level or gently sloping, loamy, permeable soil with adequate aeration but medium to high available water capacity. The pH should generally be between 6.0 and 7.0. Most soils in the survey area have a slightly acid or neutral surface layer. In many cases, however, where the subsoil has been mixed with the surface layer the soil may require liming. The amount of lime to be added should be determined by soil tests.

The soils in Washington and Ramsey Counties that are well suited to flower and vegetable gardens are the nearly level or gently sloping Antigo, Campia, Grays, Hayden, Ostrander, Richwood, Santiago, and Waukegan soils. All of these, except the Antigo and Waukegan soils, are deep, well drained, and easily tilled and have moderate to high available water capacity. The Antigo and Waukegan soils have coarse textured underlying materials at depths of 20 to 40 inches and may be slightly droughty during dry periods.

Crystal Lake, Freeon, Lindstrom, and Nessel soils are only moderately well drained. Planting in spring may be delayed 2 to 4 weeks until after frost because of wetness. Once these soils dry out, they are easy to till.

Anoka, Braham, Burkhardt, Chetek, Demontreville, Dickman, Emmert, Gotham, Hubbard, Mahtomedi, Rosholt, Sparta, and Zimmerman soils are extremely sandy throughout the rooting zone. Although they are the earliest to warm up in spring, they do not hold enough moisture to carry flowers and vegetables through the growing season without irrigation.

A number of vacant lots throughout the area are used for community gardening. Bringing vacant lots into cultivation destroys weeds and debris that may harbor vermin. It is necessary that gardens be well kept and harvested on time to avoid attracting vermin.

Inner-city gardens have a few problems that some gardens in more open spaces do not. They are more likely to be detrimentally influenced by shade cast by buildings or overhanging tree canopies, by root systems from nearby trees, and by shrubs sapping moisture away

from the gardens during critical dry periods. On the other hand, inner-city gardens may have access to irrigation water from hydrants and from spigots at dwellings and are less susceptible to killing frosts in spring and fall.

VINES AND GROUND COVER

In many urban areas the ground should be covered with plants, but because of topography, shade, or other conditions, it is not practical to grow grass. Even if grass could be grown, other factors may make it more practical to use some other plant for ground cover.

A ground cover plant should be able to grow under adverse conditions; it should grow rapidly enough to cover and protect the area; it should be easily propagated; and it generally should be low-growing and able to tolerate some foot traffic.

Many common vines and ground cover plants, too numerous to mention in this publication, will tolerate the properties of the various soils in the survey area. These species can be determined by consulting Extension Service, Soil Conservation Service, local nurserymen, horticulturists, or library references. These same references should be consulted for adaptability of the plants to special conditions such as shade, sun, or steep slopes. These are especially important considerations for soils mapped in Urban land complexes, where multi-story buildings may shade an area most of the day or where steep, dry slopes have been created by extensive grading and excavation.

PLANTING TREES AND SHRUBS

Trees and shrubs add much to the enjoyment of outdoor living. Numerous tree and shrub species are suitable for screens, sound barriers, beautification, shade, and wildlife food and cover. Advice from a local nurseryman, Extension agent, or soil conservationist is desirable in selecting trees and shrubs suitable to individual soils.

Before the tree or shrub can begin growing, it must be planted in a manner to ensure survival. Soil preparation for planting is critical in urban areas where the soils have been severely disturbed. In the soil complexes that are dominantly Urban land, the original soil material has, in many places, been graded, removed, filled, or compacted. The soils also may have been chemically altered by salts, oil, lime, or other elements of the building trade. To avoid the risk of losing an expensive ornamental plant in these areas, one should consider backfilling around the root system with good topsoil (*6*).

TREES AND SHRUBS FOR NOISE ABATEMENT

Noise from car traffic can be reduced by planting trees and shrubs between the noise source and the area to be protected. For best results, trees and shrubs should be planted close to the noise source rather than close to the area that needs protection. Where year-round noise screening is desired, dense barriers of evergreens or deciduous trees are recommended. Very thinly planted trees or trees that are in poor condition as a result of neglect or unfavorable growth environment offer little resistance to the passage of sound. A knowledge of how sound travels out-of-doors, aided by experience, is necessary to make valid judgments on the use of trees and shrubs as sound barriers. Once the general requirements are known, appropriate species can be selected with the help of a nurseryman or specialist.

LAWN GRASSES

Grasses for shaded areas. Two factors that complicate growing turf in shade are the lower light intensity, with its effect on physiological development, and the competition of trees for water and nutrients. The shade producers also commonly restrict air movement or drainage and thereby create humid, disease-favoring conditions. Shade has the effect of moderating temperature.

Where the landscape plant calls for turf in shade, the effects of that shade should be minimized by removing unnecessary trees, pruning remaining trees to let in as much light as possible, and immediately removing fallen leaves and branches. Good management includes using shade-tolerant grasses, using minimum amounts of nutrients for both trees and grass, maintaining nearly neutral reaction (pH), irrigating deeply but infrequently, and, in severe cases, using fungicides.

Red fescue is the most shade tolerant of the grasses, and tall fescue is only slightly less tolerant. Kentucky bluegrass is favored for open shade. These three grasses should be included in any mixture for use in shade.

Grasses for sunny locations. In full sun a wider range of grasses can be grown, such as bluegrasses, bentgrasses, fine fescue, and coarse fescue. Where summer use and reflected heat from adjacent buildings or pavement are not excessive, bluegrass does well. For best results, two or three varieties of bluegrass should be mixed with red fescue; no more than half the mixture should be fescue.

Grasses for visual effect. Lawns maintained for visual effect can be divided into two groups: those seen from a low angle or from a distance, and those seen from a high angle at close range. For the first group any species which can be mowed and will control erosion is satisfactory. The second group is the generally small picture lawn in which every blade can be seen. Traffic is usually minimal on these lawns. In full sun, where high temperatures are anticipated, more slowly growing varieties such as buffalograss and blue grama are recommended. For other show areas, bluegrass and red fescue may be recommended for sun or partial shade.

Grasses for areas of heavy use. Heavy traffic damages grass plants directly by trampling and indirectly by compacting the soil, thereby excluding air and water from the roots.

One of the most common high traffic areas is the shortcut, or path. Consideration should be given to paving the walkway—on a smaller scale stepping stones or gravel walks will often be sufficient—or redesigning the area so that traffic will naturally use existing paved walks.

Larger areas where turf is desired, such as ballfields and playgrounds, should be seeded with wear-resistant grass and the soil should be treated to withstand the effects of compaction. The primary grasses suitable for these heavy duty areas are Kentucky bluegrass and red fescue. In some situations, it may be desirable to include bromegrass and switchgrass in the mixture or blue grama and buffalograss for excellent wear resistance. Regardless of the seeding mixture, it is necessary to maintain the reaction near neutral, maintain adequate levels of phosphate and potash, and supply moderate amounts of nitrogen to keep plant growth vigorous but not lush.

Sanitary facilities

Table 11 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated

slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of these materials. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 12 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 14.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic

matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 13 soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water-control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in

diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and chemical properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of

each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.
5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.
6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 15, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and water features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils

that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snow melt and water in swamps and marshes is not considered flooding.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The kind of rock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*7*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 17, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Hapludolls (*Hapl*, meaning minimal horizonation, plus *udoll*, the suborder of the Mollisols that have an udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Hapludolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Hapludolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil series and morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*5*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*7*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Soil maps for detailed planning."

Algansee series

The Algansee series consists of somewhat poorly drained, very rapidly permeable soils that formed in sandy alluvium on flood plains. Slope ranges from 0 to 3 percent.

Algansee soils are similar to the Lino and Soderville soils and are commonly adjacent to the Dickman and Sparta soils. The somewhat excessively drained Dickman soils are higher on the landscape. The somewhat poorly drained Lino soils are on outwash plains and do not flood. The somewhat poorly drained Soderville soils have an argillic horizon. The excessively drained Sparta soils are higher on the landscape than Algansee soils.

Typical pedon of Algansee loamy sand, 1,980 feet west and 2,440 feet north of the southeast corner of section 26, T. 27 N., R. 22 W.

A1—0 to 6 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; moderate medium granular structure; very friable; slightly acid; abrupt smooth boundary.

C1—6 to 20 inches; dark brown (10YR 4/3) sand, pale brown (10YR 6/3) dry; common fine faint yellowish brown (10YR 5/4) mottles; weak medium granular structure; very friable; neutral; clear smooth boundary.

C2—20 to 44 inches; brown (10YR 4/3) sand; common fine faint grayish brown (10YR 5/2) and common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; neutral; clear smooth boundary.

C3—44 to 60 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; neutral.

The reaction of the control section ranges from neutral to mildly alkaline. The dominant texture of the control section is sand, but fine sand, loamy sand, or loamy fine sand with thin strata of loam or sandy loam are included in the range.

The A horizon has hue of 10YR or 7.5YR, value of 2 through 4, and chroma of 1 through 3. The C horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 3 through 6. Gravelly subhorizons are in some pedons below a depth of 40 inches.

Anoka series

The Anoka series consists of well drained, moderately rapidly permeable soils that formed in sandy outwash material. These soils are on outwash plains. Slope is 0 to 9 percent.

These soils, as mapped in Washington and Ramsey Counties, have a sandy rather than a coarse-loamy argillic horizon. They also have more rapid permeability than is defined as the range for the series. These differences, however, do not alter their usefulness or behavior.

Anoka soils are similar to the Gotham and Zimmerman soils and are commonly adjacent to the Isanti, Lino, Soderville, and Zimmerman soils. Gotham soils are dominantly medium sand and are redder than Anoka soils. Zimmerman soils lack an argillic horizon. The very poorly drained Isanti soils are in depressional areas. The somewhat poorly drained Lino and Soderville soils are in lower areas where the regional water table is high.

Typical pedon of Anoka loamy fine sand, 0 to 3 percent slopes, 2,040 feet west and 300 feet south of the northeast corner of section 31, T. 31 N., R. 21 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak medium platy structure; very friable; many roots; about 2 percent coarse fragments; strongly acid; abrupt smooth boundary.

A2—9 to 20 inches; grayish brown (10YR 5/2) loamy fine sand, pale brown (10YR 6/3) dry; weak medium platy structure; very friable; few roots; about 2 percent coarse fragments; worm casts of Ap material in upper part; medium acid; abrupt smooth boundary.

B2t—20 to 27 inches; brown (10YR 5/3) and dark brown (7.5YR 4/4) loamy fine sand; brown (10YR 5/3) coatings on vertical and horizontal faces of peds; weak fine and medium subangular blocky structure; friable; few roots; about 5 percent coarse fragments; many moderately thick clay films on ped faces and clay bridges between sand grains; medium acid; abrupt smooth boundary.

A'2—27 to 35 inches; brown (10YR 5/3) fine sand; weak fine subangular blocky structure; loose; about 1 percent coarse fragments; some smears and streaks of dark brown (10YR 3/3); medium acid; abrupt wavy boundary.

B'2t—35 to 42 inches; dark brown (7.5YR 4/4) loamy fine sand; weak fine and medium platy structure; very friable; very weakly cemented when dry; continuous thin clay bridges between sand grains; about 1 percent coarse fragments; medium acid; abrupt wavy boundary.

B3—42 to 60 inches; dark yellowish brown (10YR 4/4) loamy fine sand (B'23t); alternating with pale brown (10YR 6/3) fine sands (A'23); weak medium platy structure; single grain; bands are 1 to 4 inches thick; friable to loose; very weakly cemented when dry; medium acid.

The solum thickness is 50 to more than 60 inches. The Ap horizon has value of 3 or 4 and chroma of 1 through 3. The A2 horizon has value of 4 through 6 and chroma of 2 or 3. The A horizon is loamy fine sand, fine sand, loamy fine sand, or very fine sand. The B2t horizon has hue of 10YR or 7.5YR and value and chroma of 3 through 5. It is fine sandy loam, very fine sandy loam, or loamy fine sand. Most pedons have A'2 and B'2t horizons with color and texture similar to the A2 and B2t horizons.

Antigo series

The Antigo series consists of well drained soils that formed in a moderately deep silty mantle over sandy outwash. Permeability is moderate in the upper silty mantle and very rapid in the underlying material. Slope is 0 to 18 percent.

Antigo soils are similar to the Campia, Rosholt, and Santiago soils and are commonly adjacent to the Barronett, Brill, and Poskin soils. The very poorly drained Barronett soils are in depressional areas. The moderately well drained Brill soils are on the lower side slopes. Campia soils formed in stratified loamy and silty lacustrine sediments. The somewhat poorly drained Poskin soils are in slight depressions and drainageways. The Santiago soils formed in a silty mantle of glacial till. The Rosholt soils formed in a loamy mantle of glacial outwash.

Typical pedon of Antigo silt loam, 6 to 12 percent slopes, 1,190 feet east and 150 feet north of the southwest corner of section 12, T. 28 N., R. 21 W.

A1—0 to 2 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate very fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A21—2 to 8 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 7/2) dry; weak medium platy structure; friable; medium acid; clear smooth boundary.

A22—8 to 13 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 7/2) dry; weak coarse platy

structure parting to weak very fine subangular blocky; friable; medium acid; clear smooth boundary.
B21t—13 to 19 inches; dark brown (7.5YR 4/4) silt loam; moderate very fine and fine subangular blocky structure; friable; few thin clay films on ped faces; medium acid; clear smooth boundary.
B22t—19 to 26 inches; dark brown (7.5YR 4/4) silt loam; moderate fine subangular blocky structure; friable; few thin clay films on ped faces and in pores; medium acid; clear smooth boundary.
IIB3—26 to 38 inches; dark brown (7.5YR 4/4) loamy sand; single grain; loose; about 10 percent coarse fragments; medium acid; abrupt smooth boundary.
IIC—38 to 60 inches; dark brown (7.5YR 4/4) gravelly sand; single grain; loose; about 20 percent coarse fragments; slightly acid.

The silty mantle ranges from about 20 to 36 inches thick. The A1 horizon has value of 3 or 4 and chroma of 2 or 3. The A2 horizon has value of 4, 5, or 6 and chroma of 2 or 3. It ranges from medium acid through strongly acid. There is a B&A horizon in some pedons. The B2t horizon has hue of 5YR or 7.5YR and value and chroma of 4 or 5. It is silt loam or heavy loam. The B2 horizon ranges from medium acid to very strongly acid. Some pedons lack a IIB3 horizon. The IIC horizon has hue of 7.5YR or 5YR, value of 3 through 5, and chroma of 4. The texture is sand, coarse sand, gravelly sand, or gravelly coarse sand. The IIB3 and IIC horizons are 3 to 10 percent cobbles and 2 to 35 percent gravel.

Auburndale series

The Auburndale series consists of poorly drained, moderately permeable or moderately slowly permeable soils that formed in a moderately deep mantle of silty deposits over loamy glacial till on uplands. These soils are in drainageways and depressions. Slope ranges from 0 to 1 percent.

Auburndale soils are similar to the Prebish soils and are commonly adjacent to the Freeon, Freer, and Santiago soils. The Prebish soils are in similar positions to Auburndale soils but formed entirely in loamy glacial till. The moderately well drained Freeon soils and well drained Santiago soils are in higher, more sloping positions on the landscape. The somewhat poorly drained Freer soils are in slightly higher positions.

Typical pedon of Auburndale silt loam, 890 feet south and 600 feet east of the northwest corner of section 28, T. 29 N., R. 21 W.

A1—0 to 7 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 6/1) dry; weak medium granular structure; friable; medium acid; abrupt smooth boundary.
A2—7 to 12 inches; gray (10YR 6/1) silt loam, white (10YR 8/1) dry; common medium faint strong brown (7.5YR 5/6) and reddish yellow (7.5YR 6/6) mottles; weak thick and medium platy structure; friable; medium acid; clear irregular boundary.
B&A—12 to 17 inches; light brownish gray (10YR 6/2) silt loam (B2t); many common distinct strong brown (7.5YR 5/6) and reddish yellow (7.5YR 6/8) mottles; weak medium platy structure parting to fine subangular blocky; gray (10YR 6/1) tongues of silt loam (A2) are about 20 percent of the matrix; friable; medium acid; clear smooth boundary.
B21tg—17 to 40 inches; gray (10YR 6/1) heavy silt loam; many medium distinct strong brown (7.5YR 5/6) and dark brown (7.5YR 4/4) mottles; weak medium prismatic structure parting to weak medium angular and subangular blocky; friable; few thin clay films on ped faces; few small iron manganese concretions; strongly acid; clear smooth boundary.
B22tg—40 to 45 inches; gray (10YR 6/1) heavy silt loam; common medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; few thin clay films on ped faces; few small iron manganese concretions; 1- to 2-inch sandy strata; medium acid; abrupt smooth boundary.
IIC—45 to 60 inches; reddish brown (5YR 4/4) sandy loam; few medium faint strong brown (7.5YR 5/6) mottles; weak very thick platy structure; firm dense consistence, brittle when dry; about 8 percent coarse fragments; neutral.

The solum thickness typically ranges from about 30 inches to 48 inches. The thickness of the silty mantle typically is 30 to 48 inches but ranges to 60 inches. The solum is strongly acid or medium acid.

The A1 or Ap horizon has value of 2 or 3 and chroma of 1 or 2. Dry colors have values of 5 or 6. The A2 horizon has value or 5 or 6 and chroma of 1 or 2. The A2 horizon extends into the B horizon as tongues and interfingers. The B2 horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 5 or 6; and chroma of 1 or 2. Strata of sand 1 inch to 3 inches thick are above the IIC horizon in some pedons. A silty C horizon is in some pedons. The IIC horizon has hue of 7.5YR or 5YR and value and chroma of 3 or 4. Texture is sandy loam, fine sandy loam, or loam. Reaction is slightly acid or neutral. Coarse fragments in the IIC horizon range from 5 to 20 percent.

Barronett series

The Barronett series consists of poorly drained, moderately slowly permeable soils on glacial lake plains. They formed in silty lacustrine sediments. Slope ranges from 0 to 2 percent.

The Barronett soils are similar to Comstock soils and are commonly adjacent to Grays soils on the landscape. Comstock soils lack the dark colored surface horizon and have stratified silt loam, very fine sandy loam, and very fine sand underlying materials. Grays soils lack mottles in the upper part of the argillic horizon and are higher on the landscape than Barronett soils.

Typical pedon of Barronett silt loam, 2,145 feet west and 1,685 feet north of the southeast corner of section 32, T. 30 N., R. 22 W.

A1—0 to 7 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate very fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A2—7 to 12 inches; very dark gray (10YR 3/1) silt loam; light gray (10YR 6/1) dry; moderate coarse platy structure parting to moderate very fine subangular blocky; friable; medium acid; clear smooth boundary.

B21t—12 to 17 inches; dark grayish brown (10YR 4/2) silty clay loam; strong fine subangular blocky structure; friable; many thin very dark gray (10YR 3/1) clay films on ped faces and in pores; medium acid; clear smooth boundary.

B22t—17 to 25 inches; dark grayish brown (10YR 4/2) silty clay loam; moderate fine subangular blocky structure; friable; many thin very dark grayish brown (10YR 3/2) clay films in pores; medium acid; clear smooth boundary.

B23t—25 to 30 inches; grayish brown (2.5Y 5/2) silt loam; few fine distinct yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; friable; common thin very dark grayish brown (10YR 3/2) clay films in pores; medium acid; abrupt smooth boundary.

B3t—30 to 39 inches; variegated light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) silt loam; common fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; few thin olive gray (5Y 5/2) clay films on ped faces; very slight effervescence; mildly alkaline; clear smooth boundary.

C—39 to 60 inches; mixed light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) silt loam; few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; very slight effervescence; mildly alkaline.

The thickness of the solum and depth to free carbonates range from 25 to 40 inches. The A horizon typically is slightly acid or medium acid. The B horizon is medium acid or strongly acid in the upper part and slightly acid to mildly alkaline in the lower part.

The A1 or Ap horizon has value of 2 or 3 and chroma of 1. The texture typically is silt loam, but loam is within the range. The A2 horizon has value of 3 through 5 and chroma of 1 or 2 when the moist value is 3, the dry value is 6 or 7.

The B2t horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2. Texture includes silt loam, silty clay loam, and loam.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2, 3, or 4. The texture typically is silty clay loam or silt loam and can be stratified with fine sandy loam, very fine sandy loam, or loam. In some areas the underlying material below 40 inches is sand. Soft to hard accumulations of calcium carbonate are common in the C horizon.

Baytown series

The Baytown series consists of well drained soils that formed in a moderately deep silty and loamy mantle over sandstone bedrock on uplands. Permeability is moderate in the silty and loamy material. Slope ranges from 1 to about 12 percent.

The Baytown soils are commonly adjacent to Gale, Ostrander, and Waukegan soils. Gale soils are on similar topographic positions to Baytown soils but lack a mollic epipedon. Ostrander soils formed in a silt mantle over glacial till. Waukegan soils are on similar topographic positions but formed in a silt mantle over sand and gravel glacial outwash.

Typical pedon of Baytown silt loam, 1 to 6 percent slopes, 160 feet north and 160 feet west of the southeast corner of section 6, T. 27 N., R. 20 W.

Ap—0 to 11 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; friable; strongly acid; abrupt smooth boundary.

A12—11 to 16 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; moderate fine platy structure parting to weak fine subangular blocky; friable; strongly acid; clear smooth boundary.

A13—16 to 19 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure; friable; very strongly acid; clear smooth boundary.

B1—19 to 22 inches; dark brown (10YR 4/3) silt loam; weak very fine subangular blocky structure; friable; very strongly acid; clear smooth boundary.

B21—22 to 29 inches; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; firm; very strongly acid; clear smooth boundary.

B22—29 to 32 inches; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; firm; very few thin clay films on vertical ped faces; very strongly acid; abrupt smooth boundary.

IIB3—32 to 36 inches; yellowish brown (10YR 5/4) loamy sand; few fine faint light yellowish brown (10YR 6/4) mottles; single grain; loose; strongly acid; clear smooth boundary.

IICr—36 inches; light gray (10YR 7/2) to yellow (10YR 7/6) weakly indurated sandstone bedrock.

The thickness of the solum ranges from 20 to 40 inches. The mollic epipedon is 10 to 19 inches thick.

The A horizon has color value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It commonly is silt loam, but very fine sandy loam and loam high in silt are within the range. The B1 and B2 horizons have value of 3 through 5 and chroma of 3 or 4, with the darker colors in the upper part. They are silt loam or loam and average between 18 and 24 percent clay. Most pedons have a IIB or IIC horizon immediately above the bedrock. Typically, hue is 10YR or 7.5YR, but it ranges to 5YR in

some pedons. Value ranges from 5 through 8 and chroma from 1 through 5. Texture is loamy sand, fine sand, or loamy fine sand.

Blomford series

The Blomford series consists of poorly drained soils on uplands. These soils formed in a moderately thick mantle of sandy deposits over loamy glacial till. They have rapid permeability in the upper sandy mantle and moderate permeability in the underlying loamy material. Slope ranges from 0 to 3 percent.

The Blomford soils are similar to the Dundas and Webster soils and are commonly adjacent to the Braham and Kratka soils. The Dundas and Webster soils are in similar positions on the landscape to Blomford soils but formed entirely in loamy glacial till. The well drained Braham soils are in the higher landscape positions, and the very poorly drained Kratka soils are in lower positions than Blomford soils.

Typical pedon of Blomford loamy fine sand, 2,404 feet north and 150 feet west of the southeast corner of section 7, T. 32 N., R. 21 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loamy fine sand, light brownish gray (10YR 6/2) dry; coarse granular structure; very friable; plentiful roots; neutral; abrupt smooth boundary.

A21—9 to 19 inches; grayish brown (10YR 5/2) loamy fine sand, light gray (10YR 7/2) dry; common medium distinct strong brown (7.5YR 5/6) and dark brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; very friable; few roots; medium acid; clear wavy boundary.

A22—19 to 25 inches; grayish brown (10YR 5/2) loamy fine sand, light gray (10YR 7/2) dry; many coarse distinct strong brown (7.5YR 5/6) and dark brown (7.5YR 4/4) mottles; weak fine and very fine subangular blocky structure; very friable; few roots; 2 percent coarse fragments; strongly acid; clear smooth boundary.

IIB21t—25 to 34 inches; grayish brown (10YR 5/2) sandy clay loam; common medium faint yellowish brown (10YR 5/6) mottles; weak fine prismatic structure parting to moderate medium subangular blocky; friable; few roots; 5 percent coarse fragments; common dark gray (10YR 4/1) thick clay films on ped faces and old root channels; strongly acid; clear smooth boundary.

IIB22t—34 to 39 inches; grayish brown (10YR 5/2) sandy clay loam; few medium faint yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few roots; 5 percent coarse fragments; few moderately thick clay films on ped faces and root channels; many soft iron manganese (2 to 5 mm) concretions; strongly acid; clear smooth boundary.

IIC1—39 to 60 inches; olive (5Y 5/3) loam; many medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; massive; friable; 6 percent coarse fragments; common shale fragments; iron manganese concretions; moderately alkaline; strongly effervescent.

The thickness of the solum commonly is 36 to 52 inches, and the depth to loamy materials typically is 20 to 40 inches. Reaction is strongly acid to neutral in the upper sandy horizons, strongly acid to neutral in the IIB horizon, and neutral to moderately alkaline in the IIC horizon.

The Ap and A1 horizons have value of 2 or 3 and chroma of 1 or 2. The A2 horizon has value of 5 or 6 and chroma of 1 or 2. Texture of the A horizon is loamy fine sand, loamy sand, fine sand, or sand. The IIB horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 1 or 2. It is fine sandy loam or sandy clay loam. Some pedons have a B horizon in the upper sandy sediments. The IIC horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 through 3. It is loam, fine sandy loam, silt loam, or sandy clay loam.

Bluffton series

The Bluffton series consists of very poorly drained, moderately slowly permeable soils that formed in loamy glacial till. These soils are in depressions and drainageways on uplands. Slope is less than 2 percent.

Bluffton soils are similar to the Auburndale and Prebish soils and are commonly adjacent to the Dundas, Hayden, and Nessel soils. Auburndale soils formed in silty mantled loamy till. The poorly drained Dundas soils are in slightly higher depressions and drainageways than Bluffton soils. The better drained Hayden and Nessel soils are in higher, more sloping positions on the landscape. Prebish soils formed in coarser textured loamy glacial till.

Typical pedon of Bluffton loam, 2,200 feet west and 1,740 feet south of the northeast corner of section 6, T. 30 N., R. 21 W.

Ap—0 to 8 inches; black (10YR 2.5/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; plentiful roots; about 3 percent coarse fragments; slightly acid; abrupt smooth boundary.

A12—8 to 15 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; few roots; about 3 percent coarse fragments; slightly acid; clear smooth boundary.

A3—15 to 19 inches; black (10YR 2/1) loam; weak medium prismatic structure parting to weak medium subangular and angular blocky; friable; few roots; about 3 percent coarse fragments; few thin clay films on shiny coatings on faces of peds; slightly acid; abrupt smooth boundary.

B2g—19 to 22 inches; dark gray (5Y 4/1) fine sandy loam; few medium prominent yellowish brown (10YR

5/6) mottles; weak medium prismatic structure parting to weak medium angular and subangular blocky; friable; few roots; few thin black coatings on vertical faces of prisms; about 6 percent coarse fragments; few limestone pebbles; neutral; clear smooth boundary.

C1g—22 to 26 inches; light olive gray (5Y 6/2) fine sandy loam; few medium distinct greenish gray (5BG 6/1) and pale olive (5Y 6/4) mottles; massive; friable; few roots; olive gray (5Y 4/2) and dark olive gray (5Y·3/2) fillings in old root channels; about 5 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

C2g—26 to 38 inches; gray (5Y 6/1) loam; few medium distinct greenish gray (5BG 6/1) and olive yellow (5Y 6/6) mottles; massive; friable; few roots; about 4 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

C3g—38 to 60 inches; light olive gray (5Y 6/2) sandy clay loam; many coarse prominent greenish gray (5BG 6/1) and strong brown (7.5YR 5/8) mottles; massive; few roots; about 4 percent coarse fragments; strong effervescence; moderately alkaline.

The solum thickness and depth to free carbonates range from 15 to 45 inches. The mollic epipedon commonly is 10 to 16 inches thick and has an extreme range of 7 to 24 inches. Some pedons have an O horizon up to 6 inches thick.

The A1 or Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1, or it is N2/0 or N3/0. It is commonly loam or silt loam, but sandy loam and sandy clay loam are in the range. The B horizon has hue of 5Y or 2.5Y, value of 4 through 6, and chroma of 1 or 2. It has few through many, faint through prominent mottles, and it has few or common dark colored tongues or coatings on vertical faces of peds. It commonly is fine sandy loam or loam, but light clay loam and sandy clay loam are in the range. The C horizon has hue of 5Y or 2.5Y, value of 5 or 6, and chroma of 1 or 2. It typically is loam, fine sandy loam, or sandy clay loam, but subhorizons with coarser texture are in some pedons. It is mildly or moderately alkaline.

Braham series

The Braham series consists of deep, well drained soils on till plains near the margins of sandy outwash plains and stream terraces. These soils formed in a moderately deep sandy mantle over loamy glacial till. They have rapid permeability in the sandy surface mantle and moderate permeability in the underlying glacial till. Slope ranges from 1 to 15 percent.

The Braham soils are similar to the Demontreville and Hayden soils and are commonly adjacent to the Blomford and Kratka soils. The Blomford soils are poorly drained and are on lower or less sloping terrain. The Demontreville soils formed in a 20- to 40-inch sandy mantle over reddish loamy glacial till. The Hayden soils formed entirely in loamy glacial till. The Kratka soils are poorly drained and are in depressions.

Typical pedon of Braham loamy fine sand, 1 to 6 percent slopes, 2,340 feet east and 1,320 feet north of the southwest corner of section 14, T. 32 N., R. 21 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak very fine and fine subangular blocky structure; very friable; plentiful roots; slightly acid; abrupt smooth boundary.

A2—9 to 28 inches; yellowish brown (10YR 5/3) loamy fine sand, pale brown (10YR 6/3) dry; single grain; loose; few roots; many krotovinas; one 10- and 15-mm wide obtuse dark reddish brown (5YR 3/4) band; medium acid; abrupt wavy boundary.

IIB21t—28 to 35 inches; dark yellowish brown (10YR 4/4) sandy clay loam; weak medium prismatic structure parting to moderate medium subangular and angular blocky; friable; few roots; many thin light gray (10YR 7/2) very fine sand coatings on vertical faces of peds; medium acid; clear smooth boundary.

IIB22t—35 to 39 inches; dark yellowish brown (10YR 4/4) sandy clay loam; weak medium prismatic structure parting to weak medium and coarse subangular and angular blocky; friable; few roots; common moderately thick very dark grayish brown (10YR 3/2) clay films on vertical ped faces and in root channels; few 1- to 3-mm iron manganese concretions; strongly acid; clear smooth boundary.

IIC1—39 to 43 inches; olive brown (2.5Y 4/4) fine sandy loam; massive; friable; few roots; few moderately thick dark reddish brown (5YR 3/3) clay films on vertical fractures and in small root channels; slight effervescence; mildly alkaline; clear smooth boundary.

IIC2—43 to 60 inches; olive brown (2.5Y 4/4) loam; massive parting to weak very thick platy structure; friable; few 1- to 3-mm iron manganese concretions; very few moderately thick dark reddish brown (5YR 3/2) clay films on vertical fractures; strong effervescence; mildly alkaline.

The thickness of the solum commonly is 38 to 50 inches, and the depth to loamy materials in 20 to 40 inches. The reaction of the A and B horizons ranges from medium acid to neutral, and the IIB horizon is strongly acid to neutral. The IIC horizon is mildly alkaline or moderately alkaline.

The Ap horizon has value of 3 or 4 and chroma of 1 through 3. The A2 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 or 3. The A horizon is loamy fine sand, fine sand, sand, or loamy sand. The IIB horizon has value of 4 or 5 and chroma of 3 or 4. It has mottling in the lower part in some pedons. It is sandy clay loam, fine sandy loam, or loam. Thin to thick clay films are on the faces of some peds and in some voids

of most profiles. Some pedons have a B1 horizon in the upper sediment. The IIC horizon has hue of 2.5Y or 10YR, value of 4 through 6, and chroma of 2 through 4. It is loam, fine sandy loam, sandy clay loam, or silt loam.

Brill series

The Brill series consists of moderately well drained soils on glacial outwash plains. They formed in silty sediments over thick deposits of glacial sandy outwash. These soils have moderate permeability in the silty mantle and very rapid permeability in the underlying glacial outwash. Slope ranges from 1 to 3 percent.

These soils, as mapped in Washington and Ramsey Counties, lack the tongueing of albic materials into the argillic horizon that is characteristic of Brill soils elsewhere. This difference, however, does not alter their usefulness or behavior.

Brill soils are similar to Crystal Lake soils and are commonly adjacent to Antigo, Barronett sandy substratum, Poskin, and Rosholt soils. The well drained Antigo soils occupy higher and steeper positions on the landscape. The poorly drained Barronett, sandy substratum, soils are in depressions. Crystal Lake soils formed in silty and loamy lacustrine sediments. The Poskin soils are somewhat poorly drained and are on lower or less sloping terrain. The well drained Rosholt soils are in more sloping positions on the landscape than the Brill soils.

Typical pedon of Brill silt loam, 950 feet south and 250 feet west of the northeast corner of section 36, T. 31 N., R. 21 W.

A1—0 to 3 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine granular structure; plentiful roots; friable; strongly acid; abrupt smooth boundary.

A2—3 to 11 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; weak fine and very fine platy structure; friable; many roots; strongly acid; clear wavy boundary.

B&A—11 to 14 inches; dark brown (10YR 4/3) silt loam; grayish brown (10YR 5/2) continous thin coatings of sand and silt particles on vertical and horizontal faces of peds; weak fine angular and subangular blocky structure; many roots; friable; strongly acid; clear smooth boundary.

B21t—14 to 27 inches; brown (10YR 5/3) silt loam; moderate fine angular blocky structure; very few thin clay films on ped faces; friable; few roots; medium acid; clear smooth boundary.

B22t—27 to 35 inches; dark brown (7.5YR 4/4) silt loam; common coarse faint strong brown (7.5YR 5/6) and brown (7.5YR 5/2) mottles; weak medium subangular blocky structure; few thin clay films on faces of peds; friable; few roots; medium acid; abrupt smooth boundary.

IIC1—35 to 49 inches; reddish brown (5YR 4/3) gravelly coarse sand; common coarse faint yellowish red (5YR 5/6) and light reddish brown (5YR 6/3) mottles; single grain; loose; about 6 percent coarse fragments; medium acid; abrupt smooth boundary.

IIC2—49 to 60 inches; strong brown (7.5YR 5/6) loamy fine sand and fine sand; weak thick and very thick platy structure; friable; about 10 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 20 to 40 inches, and the silty mantle ranges in thickness from 20 to 36 inches. The IIB and IIC horizons are 2 to 20 percent gravel by volume. The solum is medium acid or strongly acid.

The A1 or Ap horizon has value of 2 through 4 and chroma of 1 through 3. The A2 horizon has value of 4 through 6 and chroma of 2 or 3. The B&A horizon has tongues of A2 material and has color and texture like the A2 horizon and the Bt horizon. The B2t horizon has hue of 10YR or 7.5YR and value and chroma of 3 through 5. The IIC horizon has hue of 10YR, 7.5YR, or 5Y and value and chroma of 3 through 6. It is stratified sand and gravelly coarse sand.

Brodale series

The Brodale series consists of excessively drained, moderately permeable soils on bedrock-controlled uplands. They formed in loamy residuum and in colluvium derived mostly from limestone bedrock. Slope ranges from 20 to 50 percent.

These soils, as mapped in Washington and Ramsey Counties, are outside the range of the official series in that they lack free carbonates in all subhorizons. This difference, however, does not alter their usefulness or behavior.

Brodale soils are similar to Dorerton and Sparta soils and are commonly adjacent to Copaston and Whalan soils. Copaston soils have a lithic contact above a depth of 40 inches. Dorerton soils lack a mollic epipedon. Sparta soils formed in glacial outwash. Whalan soils formed in loess and underlying glacial till and have a lithic contact above a depth of 40 inches.

Typical pedon of Brodale flaggy loam, 20 to 50 percent slopes, 540 feet north and 2,240 feet east of the southwest corner of section 34, T. 28 N., R. 20 W.

A1—0 to 7 inches; very dark gray (10YR 3/1) flaggy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; about 25 percent coarse fragments; neutral; clear wavy boundary.

B21—7 to 13 inches; dark brown (10YR 3/3) flaggy very fine sandy loam, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; very friable; about 30 percent coarse fragments, mostly flagstones; mildly alkaline; clear wavy boundary.

C—13 to 50 inches; brown (10YR 5/3) flaggy very fine sandy loam; massive; friable; about 60 percent coarse fragments, mostly flagstone; mildly alkaline; abrupt smooth boundary.

R—50 inches; level bedded limestone bedrock.

The thickness of the solum ranges from 8 to 20 inches, and depth to limestone bedrock is 40 to 60 inches or more. Coarse fragments are dominantly limestone flagstones and range from 25 to 70 percent. The fine earth fraction of the profile typically is sandy loam, very fine sandy loam, loam, or silt loam and less commonly is loamy sand. The solum and C horizon are neutral or moderately alkaline.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has value of 4 or 5 and chroma of 3 through 5. Secondary accumulations of free carbonates on coarse fragments range from few to many. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 through 6.

Burkhardt series

The Burkhardt series consists of somewhat excessively drained soils that formed in loamy and sandy deposits on stream terraces. Permeability is moderately rapid in the upper part and rapid in the underlying sand and gravel. Slope ranges from 0 to 9 percent.

Burkhardt soils are similar to Dickman, Hubbard, and Sparta soils and are commonly adjacent to the Hubbard and Sparta soils. Dickman soils have a more yellow hue and contain less gravel than Burkhardt soils. Hubbard soils lack cambic horizons. Sparta soils formed in fine and medium sands and lack gravel.

Typical pedon of Burkhardt sandy loam, 0 to 3 percent slopes, 800 feet south and 1,700 feet east of the northwest corner of section 2, T. 28 N., R. 20 W.

A11—0 to 7 inches; black (10YR 2.5/1) sandy loam, very dark grayish brown (10YR 3/2) dry; moderate very fine and fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

A12—7 to 13 inches; black (10YR 2.5/1) sandy loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

A3—13 to 16 inches; very dark gray (10YR 3/1) sandy loam; weak very fine and fine subangular blocky structure; friable; medium acid; abrupt smooth boundary.

IIB—16 to 23 inches; dark brown (7.5YR 3/2) gravelly loamy coarse sand; single grain; loose; medium acid; clear smooth boundary.

IIC—23 to 60 inches; brown (7.5YR 4/4) gravelly coarse sand; single grain; loose; medium acid.

The solum thickness typically is 16 to 24 inches and ranges from 12 to 24 inches. Some pedons have a thin stoneline between the upper loamy sediments and the gravelly and sandy sediments.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 through 3. It is light loam or sandy loam. Some pedons have a B2 horizon. The IIB horizon is gravelly loamy coarse sand or loamy coarse sand. The C horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 or 5 or 6. It is sand or gravelly coarse sand. Gravel content ranges from 15 to 40 percent.

Campia series

The Campia series consists of well drained, moderately permeable soils on lake plains. They formed in thick deposits of silty material. Slope ranges from 0 to 8 percent.

The Campia soils are similar to the Grays soils and are commonly adjacent to the Barronett, Comstock, and Crystal Lake soils. The Barronett soils are poorly drained and occupy depressions. The Comstock soils are somewhat poorly drained, and the Crystal Lake soils are moderately well drained. The Comstock and Crystal Lake soils are in lower, less sloping areas. The Grays soils formed in stratified silty and loamy calcareous lacustrine materials.

Typical pedon of Campia silt loam, 0 to 8 percent slopes, 1,840 feet north and 2,565 feet west of the southeast corner of section 33, T. 29 N., R. 21 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak very fine and fine subangular blocky structure; very friable; slightly acid; abrupt smooth boundary.

A2—8 to 12 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; weak thin platy structure; dark grayish brown (10YR 4/2) vesicular coatings on some ped faces; very friable; medium acid; abrupt irregular boundary.

A&B—12 to 15 inches; grayish brown (10YR 5/2) silt loam (A2); weak medium and thick platy structure; friable; about 65 percent of horizon is tongues of A2 material extending into or completely surrounding isolated remnants of dark brown (10YR 4/3) silt loam (B2t); weak fine subangular blocky structure; friable; strongly acid; clear wavy boundary.

B2t—15 to 29 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium and fine angular and subangular blocky structure; friable; faces of most most peds have thin patchy dark grayish brown (10YR 4/2) clay films; very strongly acid; clear smooth boundary.

B3—29 to 40 inches; dark brown (7.5YR 4/4) silt loam; weak medium subangular blocky structure; friable; peds have thin dark grayish brown (10YR 4/2) clay films along major vertical faces; very strongly acid; clear smooth boundary.

C1—40 to 52 inches; dark brown (7.5YR 4/4) silt loam; few coarse distinct brown (10YR 5/3) and yellowish brown (10YR 5/6) mottles; weak medium and thick platy structure; very friable; very strongly acid; gradual smooth boundary.

C2—52 to 60 inches; brown (7.5YR 5/4) silt loam; common coarse distinct grayish brown (10YR 5/2)

and yellowish brown (10YR 5/6) mottles; weak medium and thick platy structure; very friable; medium acid.

The solum thickness ranges from about 30 to 48 inches. The Ap horizon has value of 4 or 5 and chroma of 2 or 3. Pedons with an A1 horizon have lower value. The A2 horizon has value of 4 through 6 and chroma of 2 or 3. B&A and A&B horizons have tongues of A2 material surrounding thin upward extensions of the Bt horizon. The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It generally is heavy silt loam or light silty clay loam. The B2t horizon is strongly acid or very strongly acid. The lower boundary of the B2t horizon grades to similarly colored B3 and C horizons. The B3 and C horizons are dominantly silt loam that have thin strata of silty clay loam, silt, very fine sandy loam, loamy very fine sand, or fine sand.

Cathro series

The Cathro series consists of very poorly drained soils in small depressions on till plains and on the outer fringes of the larger bogs. They formed in moderately deep decomposed organic materials over loamy materials. Permeability varies from moderately slow to moderately rapid in the organic layers and from moderately slow to moderate in the underlying mineral materials. Slope is less than 2 percent.

Cathro soils are similar to the Markey soils and are commonly adjacent to the Rifle and Seelyeville soils. Markey soils have a sandy IIC horizon at a depth of less than 51 inches. Rifle and Seelyeville soils have organic layers that total more than 51 inches in depth and commonly occupy the inner regions of the larger bogs.

Typical pedon of Cathro muck, 165 feet east and 2,145 feet north of the southwest corner of section 31, T. 32 N., R. 21 W.

Oa1—0 to 13 inches; sapric material, very dark gray (10YR 3/1) on broken face and very dark grayish brown (10YR 3/2) rubbed; about 15 percent fiber, about 2 percent rubbed; massive; abundant roots; neutral; clear smooth boundary.

Oa2—13 to 32 inches; sapric material, very dark brown (10YR 2/2) on broken face and black (10YR 2/1) rubbed; about 20 percent fiber, about 2 percent rubbed; about 20 percent mineral content; weak thick platy structure parting to weak fine platy; neutral; clear smooth boundary.

Oe1—32 to 38 inches; hemic material, dark brown (7.5YR 3/2) on broken face and black (10YR 2/1) rubbed; about 35 percent fiber, about 12 percent rubbed; about 15 percent mineral content; moderate thick platy structure; neutral; abrupt smooth boundary.

IIA1b—38 to 47 inches; black (10YR 2/1) loam and silt loam; massive; friable; neutral; clear smooth boundary.

IICg—47 to 60 inches; grayish brown (2.5YR 5/2) loam and sandy loam; massive; slightly sticky; mildly alkaline; slight effervesence.

The depth to the loamy IIAb or IIC horizon is commonly 24 to 40 inches and ranges from 16 to 50 inches. The organic part of the control section has hue of 10YR and 7.5YR, value of 2 or 3, and chroma of 1 or 2. The surface tier is sapric or hemic or both. The subsurface tier is dominated by sapric material and makes up more than half of the organic material above the mineral horizon. The fiber content, unrubbed, ranges from 50 percent to less than 15 percent and is less than 12 percent after rubbing. In some pedons, layers of hemic materials are within the organic part of the control section and have a combined thickness of 10 inches or less. If there is a IIAb horizon it has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. Texture is fine sandy loam, loam, or silt loam. The IICg horizon has hue of 10YR through 5Y, value of 4 through 6, and chroma of 1 through 3. Texture is sandy loam, fine sandy loam, loam, or sandy clay loam. Reaction ranges from neutral to mildly alkaline.

Channahon series

The Channahon series consists of well drained soils which formed in 10 to 20 inches of silty glacial drift over limestone bedrock. Permeability is moderate in the loamy mantle. Slope ranges from 1 to 18 percent.

Channahon soils are similar to the Copaston soils and are commonly adjacent to Ostrander, Ripon, and Waukegan Variant soils. They differ from Channahon soils in various ways. Copaston soils lack an argillic horizon, Ostrander soils formed in silty mantled glacial till, Ripon soils formed in 20 to 40 inches of loess and glacial till over limestone bedrock, and the Waukegan Variant soils have a IIB horizon that formed in glacial outwash.

Typical pedon of Channahon silt loam, 6 to 12 percent slopes, 2,000 feet east and 300 feet north of the southwest corner of section 29, T. 27 N., R. 20 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

B21t—8 to 12 inches; dark brown (10YR 3/3) silt loam, yellowish brown (10YR 5/4) dry; moderate fine and medium subangular blocky structure; friable; few thin discontinuous clay films on ped faces; slightly acid; gradual smooth boundary.

B22t—12 to 18 inches; dark brown (10YR 4/3) silt loam; moderate fine and medium subangular blocky structure; friable; few thin discontinuous clay films on ped faces; slightly acid; abrupt irregular boundary.

IIR—18 inches; very pale brown (10YR 7/3) level-bedded limestone bedrock; upper 2 inches is highly fractured.

The solum thickness and depth to the limestone bedrock range from 10 to 20 inches. The solum ranges from slightly acid to moderately alkaline. The lower 2 to 4 inches of the B horizon contain free carbonates in some pedons. Coarse limestone fragments range from 0 to 20 percent by volume.

The A horizon has value of 2 or 3, chroma of 1 or 2, and is loam or silt loam. Some pedons have a thin B1 horizon. The B2 horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 3 or 4. It is loam, silt loam, sandy clay loam, clay loam, or silty clay loam averaging less than 35 percent clay. The limestone bedrock commonly has hue of 10YR or 2.5Y, value of 5 through 7, and chroma of 2 or 3.

Chaska series

The Chaska series consists of poorly drained and somewhat poorly drained, moderately permeable soils on flood plains. These soils formed in calcareous, loamy, recent alluvium. Slope is less than 2 percent.

Chaska soils are commonly adjacent to the Algansee and Kerston soils. The somewhat poorly drained Algansee soils formed in sandy alluvium. The very poorly drained Kerston soils formed in stratified organic and mineral alluvial sediments.

Typical pedon of Chaska silt loam, 2,370 feet north and 2,110 west of the southeast corner of section 9, T. 28 N., R. 22 W.

A1—0 to 6 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; neutral; abrupt smooth boundary.

C1—6 to 36 inches; stratified very dark grayish brown (10YR 3/2) very fine sandy loam and dark grayish brown (10YR 4/2) silt loam; few fine faint dark yellowish brown (10YR 4/4) and few fine distinct yellowish brown mottles; weak medium platy structure; friable; mildly alkaline; slight effervesence.

C2—36 to 60 inches; stratified dark grayish brown (2.5YR 4/2) very fine sandy loam and grayish brown (10YR 5/2) loamy fine sand; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak coarse platy structure; friable; mildly alkaline; slight effervesence.

Free carbonates are in all parts of these soils below a depth of 10 inches. The 10- to 40-inch control section is 18 to 27 percent clay and 15 to 30 percent fine sand or coarser. The sand fraction is mostly fine and very fine.

The A horizon has hue of 10YR or 2.5Y, value of 3, and chroma of 1 or 2. It is loam, silt loam, clay loam, or silty clay loam. It typically is neutral but ranges to mildly alkaline. The C horizon has colors in stratified pattern. Hue is mostly 10YR or 2.5Y but is 5Y in the lower part of some pedons. Value ranges from 3 through 5 and chroma from 1 through 3. Chroma of 3 is only in the lower part of the C horizon or where hue is 5Y. Mottles range from few to many. The C horizon is stratified; dominant textures are silt loam, loam, and very fine sandy loam, but the range includes fine sand, loamy fine sand, fine sandy loam, sandy clay loam, silty clay loam, and clay loam. Reaction is mildly alkaline or moderately alkaline. The content of organic matter decreases irregularly with depth in the C horizon.

Chetek series

The Chetek series consists of somewhat excessively drained soils on outwash plains. They formed in a 12- to 20-inch loamy mantle and the underlying sandy outwash material. They have moderately rapid permeability in the loamy mantle and rapid permeability in the underlying material. Slope ranges from 0 to 25 percent.

Chetek soils are similar to the Anoka and Burkhardt soils and are commonly adjacent to the Emmert, Mahtomedi, Rosholt, and Kingsley soils. Anoka soils lack gravel and their solum is dominantly fine sand or very fine sand. Burkhardt soils have a mollic epipedon. The Emmert and Mahtomedi soils are excessively drained and have a thinner loamy mantle and are on a more convex slope than Chetek soils. The Rosholt soils are well drained and formed in a 20- to 40-inch loamy mantle and underlying sands and gravel. The Kingsley soils are well drained and formed entirely in loamy glacial till.

Typical pedon of Chetek sandy loam, 0 to 6 percent slopes, 1,640 feet north and 400 feet west of the southeast corner of section 1, T. 31 N., R. 20 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) sandy loam, grayish brown (10YR 5/2) dry; weak medium granular structure; very friable; about 5 percent coarse fragments; slightly acid; abrupt smooth boundary.

A2—8 to 14 inches; brown (10YR 5/3) loam, pale brown (10YR 6/3) dry; weak medium platy structure parting to weak fine and very fine subangular blocky; very friable; about 4 percent coarse fragments; medium acid; abrupt wavy boundary.

B2t—14 to 19 inches; gravelly sandy loam with dark reddish brown (5YR 3/4) exterior and brown (7.5YR 4/4) interior; moderate fine and medium subangular blocky structure; friable; about 50 percent coarse fragments; common thin clay films on ped faces and as bridging of sand grains; medium acid; abrupt wavy boundary.

IIB3—19 to 22 inches; brown (7.5YR 4/4) gravelly coarse sand; weak medium subangular blocky structure; very friable; about 8 percent coarse fragments; medium acid; clear wavy boundary.

IIC1—22 to 38 inches; brown (7.5YR 4/4) gravelly sand; single grain; loose; about 18 percent coarse fragments; slightly acid; clear wavy boundary.

IIC2—38 to 60 inches; light brown (7.5YR 6/4) gravelly coarse sand; single grain; loose; about 18 percent coarse fragments; slightly acid.

The solum thickness and the depth to the underlying sand and gravel range from 12 to 24 inches. The A horizon is fine sandy loam, sandy loam, or loam. It has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. The A2 horizon has texture similar to that of the A1 horizon. The A2 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. In some pedons the A2 horizon has been incorporated with the Ap horizon. The B2t horizon is loam or gravelly sandy loam and is slightly acid to strongly acid in reaction. It has hue of 7.5YR or 5YR and value and chroma of 3 or 4. The average clay content in the argillic horizon ranges from 10 to about 18 percent. The IIB3 horizon has hue of 7.5YR or 5YR, value of 4, and chroma of 4 or 5. It is gravelly sandy loam or gravelly coarse sand, and it is slightly acid to strongly acid. The IIC horizon has hue of 5YR or 7.4YR and value and chroma of 4 through 6. It is gravelly and sandy and is 5 to 35 percent by volume coarse fragments. The IIC horizon ranges from slightly acid to strongly acid.

Comstock series

The Comstock series consists of deep, somewhat poorly drained, moderately permeable soils on glacial lake plains. They formed in silty eolian or lacustrine sediments. Slope ranges from 0 to 3 percent.

The Comstock soils mapped in Washington and Ramsey Counties are outside the range defined for the series in that they have a surface horizon that qualifies as a mollic epipedon. They also lack the tongueing of A2 material into the argillic horizon that is characteristic of other Comstock soils. These differences, however, do not alter the usefulness or behavior of the soils.

Comstock soils are similar to the Barronett soils and are commonly adjacent to the Campia and Crystal Lake soils. Barronett soils formed in material that is yellowish in hue. The well drained Campia soils and moderately well drained Crystal Lake soils formed in similar materials to those in which the Comstock soils formed but occupy slight rises on the lake plains.

Typical pedon of Comstock silt loam, 1,350 feet north and 1,320 feet west of the southeast corner of section 13, T. 29 N., R. 21 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; strongly acid; abrupt smooth boundary.

A2—10 to 19 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; strongly acid; clear wavy boundary.

B1—19 to 24 inches; brown (10YR 4/3) silt loam that has dark brown (10YR 3/3) coatings on ped faces; few fine distinct dark brown (7.5YR 4/4) mottles; moderate fine and medium subangular blocky structure; friable; medium acid; gradual wavy boundary.

B21t—24 to 28 inches; grayish brown (10YR 5/2) silt loam; many medium distinct yellowish brown (10YR 5/8) mottles; moderate fine and medium subangular blocky structure; friable; medium acid; gradual wavy boundary.

B22t—28 to 40 inches; brown (10YR 5/3) silt loam; many medium distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; few thin clay films in pores; medium acid; gradual wavy boundary.

B3—40 to 52 inches; brown (10YR 5/3) silt loam; many medium distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; medium acid; gradual wavy boundary.

C—52 to 60 inches; pale brown (10YR 6/3) silt loam; many medium distinct yellowish brown (10YR 5/8) mottles; massive; friable; medium acid.

The solum thickness typically is 30 to 44 inches but ranges to 59 inches. The solum ranges from medium acid to very strongly acid.

The Ap or A1 horizon has value of 3 or 4 and chroma of 1 or 2. The A2 horizon has value of 3 through 6 and chroma of 1, 2, or 3. The A horizon is dominantly silt loam, but loam is within the range. It has mottles in some pedons. The B2t horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 or 5; and chroma of 3 or 4. It is silty loam or light silty clay loam. The B2r horizon grades clearly or gradually to a multicolored C horizon. The B2 and C horizons have thin strata of silty clay loam, silt, fine or very fine sandy loam, or fine or very fine sand.

Copaston series

The Copaston series consists of well drained, moderately permeable soils that formed in 12 to 20 inches of loamy glacial drift over hard sandstone or limestone bedrock. Slope ranges from 0 to 12 percent.

Copaston soils are commonly adjacent to Brodale, Dorerton, Mahtomedi Variant, and Whalan soils. The Brodale and Dorerton soils are excessively drained and are on steeper side slopes than Copaston soils. They formed in 40 to 80 inches of loamy mantle over limestone bedrock. The Mahtomedi Variant soils are excessively drained. They formed in sandy mantled sandstone bedrock and commonly are in more sloping areas. The Whalan soils are well drained and formed in 20 to 40 inches of loamy material over limestone.

Typical pedon of Copaston loam, 0 to 6 percent slopes, 1,220 feet north and 1,450 feet east of the southwest corner of section 30, T. 32 N., R. 19 W.

A1—0 to 8 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; friable; about 5 percent coarse fragments; plentiful roots; slightly acid; abrupt smooth boundary.

B21—8 to 14 inches; dark brown (10YR 3/3) sandy loam, dark yellowish brown (10YR 4/4) dry; weak

fine and medium subangular blocky structure; friable; about 12 percent coarse fragments; few roots; medium acid; clear wavy boundary.

B22—14 to 18 inches; dark brown (7.5YR 4/4) gravelly sandy loam; weak medium subangular blocky structure; friable; about 20 percent coarse fragments; some sandstone fragments; few roots; medium acid; clear irregular boundary.

R—18 inches; brownish yellow (10YR 6/8) sandstone bedrock.

The solum thickness and depth to bedrock range from 12 to 20 inches. Coarse fragments make up less than 20 percent of the volume of the solum. The solum is medium acid to neutral.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam, fine sandy loam, loam, or silt loam. The B horizon has hue of 10YR or 7.5YR and value and chroma of 3 or 4. It is sandy loam, fine sandy loam, or loam. Typically, the boundary between the solum and the bedrock is abrupt, but a thin layer of disintegrated rock made up of less than 2 inches of discontinuous residuum is at the line of contact in some pedons.

Crystal Lake series

The Crystal Lake series consists of moderately well drained, moderately permeable soils on glacial lake plains. They formed in 20 to 40 inches of silty eolian or lacustrine sediments. Slope ranges from 1 to 3 percent.

The Crystal Lake soils mapped in Washington and Ramsey Counties are outside the range defined for the series in that they have a darker colored surface layer and they lack the characteristic tongueing of the albic horizon into the argillic horizon. These differences, however, do not alter their usefulness or behavior.

Crystal Lake soils are similar to Antigo, Campia, and Santiago soils and are commonly adjacent to the Barronett, Campia, and Comstock soils. Antigo soils are fine silty over sandy or sandy skeletal. Barronett soils are poorly drained and are in depressions and drainageways. Campia soils lack mottles in the lower part of the solum. Comstock soils are somewhat poorly drained and occupy lower lying flats. The lower part of the solum of the Santiago soils formed in glacial till.

Typical pedon of Crystal Lake silt loam, 1 to 3 percent slopes, 2,570 feet north and 1,980 feet east of the southwest corner of section 18, T. 29 N., R. 20 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

B1—9 to 16 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate fine and medium subangular blocky structure; friable; medium acid; gradual wavy boundary.

B21—16 to 23 inches; yellowish brown (10YR 5/4) silt loam; moderate fine and medium subangular blocky structure; friable; medium acid; gradual wavy boundary.

B22t—23 to 29 inches; brown (10YR 5/3) silt loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; few thin discontinuous clay films on vertical ped faces; strongly acid; gradual wavy boundary.

B23t—29 to 38 inches; brown (10YR 5/3) silt loam; many medium distinct strong brown (7.5YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; few thin discontinuous clay films on vertical ped faces; strongly acid; gradual wavy boundary.

C—38 to 60 inches; dark yellowish brown (10YR 4/4) silt loam; many medium distinct strong brown (7.5YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; medium acid.

The solum is typically 30 to 44 inches thick but ranges from 22 to 50 inches.

The Ap horizon has value of 1 through 4 and chroma of 1 through 3. The A2 horizon has value of 4 through 6 and chroma of 2 or 3. The A horizon has texture of silt loam or very fine sandy loam high in silt. The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It typically is silt loam or light silty clay loam. Few to many, faint to distinct mottles of high chroma are in the B2t and B3t horizons. The B3t and C horizons are dominantly silt loam but have thin strata of very fine sand, very fine sandy loam, and silt. The B3t and C horizons have hue of 5YR, 7.5YR, or 10YR; value of 4 through 6; and chroma of 4 or 5. The C horizon ranges from very strongly acid to medium acid.

Demontreville series

The Demontreville series consists of well drained soils on sand capped ground moraine. These soils formed in a moderately thick sandy mantle of eolian or lacustrine material and the underlying loamy glacial till. They have rapid permeability in the upper sandy mantle and moderately slow permeability in the underlying glacial till. Slope ranges from 1 to 25 percent.

Demontreville soils are similar to Braham, Kingsley, and Santiago soils and are commonly adjacent to Duluth, Kingsley, Mahtomedi, Ronneby, and Santiago soils. Braham soils formed in a moderately thick sand cap over grayish loamy glacial till. Duluth and Kingsley soils are well drained and formed entirely in loam and sandy loam glacial till. The Ronneby soils are somewhat poorly drained and formed entirely in sandy loam till. They are lower on the landscape than Demontreville soils. Mahtomedi soils formed in a thin loamy mantle over stratified sand and fine gravel. Santiago soils formed in a silty mantle and the underlying glacial till.

Typical pedon of Demontreville loamy fine sand, 2 to 6 percent slopes, 750 feet south and 2,010 feet west of the northeast corner of section 28, T. 30 N., R. 21 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) loamy fine sand, pale brown (10YR 6/3) dry; weak fine subangular blocky structure parting to single grain; very friable; about 5 percent coarse fragments; slightly acid; abrupt smooth boundary.

A21—7 to 11 inches; brown (10YR 4/3) loamy fine sand, very pale brown (10YR 7/3) dry; weak fine subangular blocky structure; very friable; about 5 percent coarse fragments; medium acid; clear irregular boundary.

A22—11 to 15 inches; brown (10YR 4/3) loamy sand, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; friable; about 10 percent coarse fragments; medium acid; clear wavy boundary.

B1—15 to 24 inches; brown (10YR 5/3) loamy sand; moderate medium subangular blocky structure; friable; about 8 percent coarse fragments; medium acid; clear irregular boundary.

IIB21t—24 to 29 inches; dark reddish brown (5YR 3/4) sandy loam; moderate medium subangular blocky structure; firm; few thin clay films along vertical cleavages; about 10 percent coarse fragments; medium acid; clear wavy boundary.

IIB22t—29 to 41 inches; dark reddish brown (5YR 3/4) sandy loam; moderate medium subangular blocky structure; firm; few thin clay films along vertical cleavages; about 10 percent coarse fragments; slightly acid; clear wavy boundary.

IIC—41 to 60 inches; dark reddish brown (5YR 3/4) sandy loam; massive; firm; about 15 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 30 to 50 inches, and depth to the glacial till ranges from 20 to 40 inches. These soils are medium acid to neutral throughout.

The A1 or Ap horizon has value of 2 through 4 and chroma of 1 through 3. The A2 horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. The A horizon typically is loamy fine sand or loamy sand, but sand or fine sand are in the range. A thin A3 horizon is in some pedons. The B and IIB horizons have hue of 10YR, 7.5YR, or 5YR; value of 3 through 5; and chroma of 3 through 6. The redder hue is in the IIB horizon. The B horizon is dominantly loamy sand and the IIB horizon is sandy loam or sandy clay loam ranging to loam. The IIC horizon has hue of 7.5YR or 5YR, value of 3 or 4, and chroma of 4 through 6. It is sandy loam or coarse sandy loam, but loamy coarse sand is in the range.

Dickman series

The Dickman series consists of somewhat excessively drained soils that formed in loamy and underlying sandy glacio-fluvial sediments on outwash plains and valley trains. Permeability is moderately rapid in the solum and rapid in the underlying material. Slope ranges from 0 to 12 percent.

Dickman soils are similar to Anoka, Chetek, Copaston, Emmert, Mahtomedi, Waukegan, and Zimmerman soils and are adjacent to Sparta or Hubbard soils. Anoka, Chetek, Emmert, Mahtomedi, and Zimmerman soils have a lighter colored surface horizon than Dickman soils. Copaston soils have limestone bedrock within 20 inches of the surface. Waukegan soils have silt loam in the A horizon and upper part of the B horizon. Hubbard and Sparta soils are sand or loamy sand in all horizons.

Typical pedon of Dickman sandy loam, 0 to 2 percent slopes, 2,590 feet east and 2,040 feet south of the northwest corner of section 21, T. 27 N., R. 21 W.

Ap—0 to 8 inches; very dark brown (10YR 2.5/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; very friable; neutral; abrupt smooth boundary.

A12—8 to 14 inches; very dark brown (10YR 2.5/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.

B2—14 to 17 inches; dark brown (10YR 3/3) sandy loam; weak medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.

IIB31—17 to 27 inches; dark brown (10YR 4/3) loamy sand; weak medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.

IIB32—27 to 40 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; slightly acid; clear smooth boundary.

IIC—40 to 60 inches; yellowish brown (10YR 5/4) sand; single grain; loose; slightly acid.

Thickness of the solum ranges from 30 to 50 inches. There are no free carbonates to a depth of 48 inches or more. Depth of loamy fine sand or coarser material ranges from 12 to 20 inches. Some pedons are as much as 5 percent gravel.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is fine sandy loam or sandy loam. The B horizon has value and chroma of 3 or 4. This horizon is fine sandy loam or sandy loam in the upper part and fine sand or sand in the lower part. The C horizon has value of 5 or 6 and chroma of 3 or 4. It is mostly fine sand or sand and commonly is stratified.

Dorerton series

The Dorerton series consists of well drained soils on bedrock controlled uplands. They formed in a loamy mantle of loess and erosional sediments and skeletal material from fragmented limestone. Permeability is moderate in the solum and moderately rapid in the underlying material. Slope ranges from 25 to 65 percent.

Dorerton soils are similar to Brodale and Whalan soils and are commonly adjacent to Copaston, Ostrander, Waukegan, and Whalan soils. Brodale soils have mollic epipedons. Copaston soils are on summits and have a

lithic contact beginning at a depth of 12 to 20 inches. Ostrander soils formed in loess mantled glacial till and have no bedrock within a depth of 60 inches. Waukegan soils formed in loess mantled glacial outwash. Whalan soils are fine-loamy and have a lithic contact beginning at a depth of 20 to 40 inches.

Typical pedon of Dorerton sandy loam from an area of Dorerton-Rock outcrop complex, 25 to 65 percent slopes, 1,980 feet east and 590 feet north of the southwest corner of section 2, T. 27 N., R. 20 W.

A1—0 to 4 inches; very dark gray (10YR 3/1) sandy loam, dark grayish brown (10YR 4/2) dry; moderate granular structure; friable; medium acid; abrupt smooth boundary.

A2—4 to 10 inches; dark brown (10YR 4/3) fine sandy loam, yellowish brown (10YR 5/4) dry; weak very fine and fine subangular blocky structure; friable; medium acid; gradual wavy boundary.

IIB21t—10 to 18 inches; dark brown (7.5YR 4/4) gravelly clay loam; moderate very fine subangular blocky structure; firm; few thin clay films on ped faces and in pores; about 20 percent limestone fragments, mostly gravel size; slightly acid; gradual irregular boundary.

IIB22t—18 to 30 inches; dark brown (7.5YR 4/4) flaggy clay loam; moderate very fine subangular blocky structure; firm; few thin clay films on ped faces; about 45 percent limestone fragments of pebble size through flagstone size; mildly alkaline; very slight effervescence; clear irregular boundary.

IIC—30 to 45 inches; pale brown (10YR 6/3) flaggy loamy sand; single grain; loose; about 75 percent limestone fragments of pebble through flagstone size; mildly alkaline; slight effervescence.

R—45 inches; level bedded limestone bedrock.

The thickness of the solum and the depth to free carbonates range from 24 to 45 inches. Limestone bedrock begins at a depth of 45 to 70 inches.

The A1 horizon has value of 2 or 3 and chroma of 1 or 2. It is medium acid through neutral. The A2 horizon has value of 3 through 5 and chroma of 2 or 3. It is strongly acid through slightly acid. The A horizon is sandy loam, fine sandy loam, loam, or silt loam. In some pedons a B horizon is in the upper sediment. The IIB2 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is gravelly or flaggy loam or clay loam that is 20 to 35 percent clay. The IIB2 horizon is medium acid to mildly alkaline. The IIC horizon has value of 6 or 7 and chroma of 3 or 4. It is sand, fine sand, loamy sand, or loamy fine sand.

Duluth series

The Duluth series consists of well drained, slowly permeable soils on glacial moraines. They formed in loamy glacial till. Slope ranges from 1 to 25 percent.

As mapped in Washington and Ramsey Counties, the Duluth soils are outside the range defined for the series. They are monosequel rather than bisequel. They also lack tongueing of A2 material in the argillic horizon. These differences, however, do not alter their usefulness or behavior.

Duluth soils are similar to Campia and Hayden soils and are commonly adjacent to Demontreville, Kingsley, Ronneby, or Santiago soils. Campia soils formed in lacustrine silts. Hayden soils formed in grayish colored calcareous loamy till. Demontreville soils formed in 20 to 40 inches of sandy eolian or lacustrine sediments and the underlying loamy glacial till. Ronneby soils are poorly drained and are in depressions. Santiago soils formed in 15 to 30 inches of loess and the underlying loamy glacial till. Kingsley soils have less clay in the control section than Duluth soils.

Typical pedon of Duluth silt loam, 1 to 6 percent slopes, 100 feet east and 1,340 feet north of the southwest corner of section 18, T. 31 N., R. 20 W.

Ap—0 to 9 inches; dark yellowish brown (10YR 4/4) silt loam, light brownish gray (10YR 6/2) dry; weak very fine granular structure; friable; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

B1—9 to 14 inches; reddish brown (5YR 4/4) loam; brown to dark brown (7.5YR 4/4) dry; moderate very fine and fine subangular blocky structure; firm; many thin coatings of clean sand and silt particles on faces of peds; about 8 percent coarse fragments; slightly acid; clear smooth boundary.

B2t—14 to 20 inches; dark reddish brown (5YR 3/4) loam; moderate fine subangular blocky structure; firm; continuous thin clay films on horizontal faces of peds; continuous thin coatings of clean sand and silt particles on vertical faces of peds and a few thin coatings on horizontal faces; about 8 percent coarse fragments; medium acid; gradual smooth boundary.

B31t—20 to 32 inches; dark reddish brown (5YR 3/4) loam; weak coarse and very coarse angular blocky structure parting to weak thin and medium platy; firm; continuous thin and medium clay films in vertical pores of peds and a few on horizontal faces of peds; few thin black coatings (Mn02) on faces of plates; about 8 percent coarse fragments; medium acid; diffuse smooth boundary.

B32t—32 to 50 inches; dark reddish brown (5YR 3/4) loam; weak thick platy structure parting to weak very fine angular blocky; firm; few black coatings (Mn02) on faces of peds; about 2 percent fine through large yellowish brown silt loam lenses; about 8 percent coarse fragments; slightly acid; diffuse smooth boundary.

C—50 to 60 inches; reddish brown (5YR 4/4) loam; massive; firm; about 2 percent fine through large inclusions of yellowish brown silt loam lenses; about 8 percent coarse fragments; neutral.

The solum thickness ranges from 40 to 60 inches, and depth to free carbonates is 42 to 80 inches.

The Ap horizon has value of 3 or 4 and chroma of 1 to 4. The reaction is medium acid or slightly acid. Texture ranges from very fine sandy loam or fine sandy loam to loam or silt loam. Some pedons have A2 and B&A horizons. The B1 horizon has value and chroma of 3 or 4 and is medium acid or slightly acid. It is fine sandy loam or very fine sandy loam to loam. The B2 and B3 horizons have hue of 2.5YR or 5YR, value of 3 or 4, and chroma of 3 through 5. Reaction is medium acid or slightly acid. The B2 and B3 horizons are loam or clay loam. Clay films range from many to continuous and thin to moderately thick in these horizons. The Bt horizon typically averages between 18 and 30 percent clay. The C horizon has hue of 2.5YR or 5YR, value of 3 or 4, and chroma of 4 through 6. It is loam or sandy loam. Reaction is neutral to mildly alkaline.

Dundas series

The Dundas series consists of poorly drained, moderately slowly permeable soils on ground moraines. They formed in calcareous loamy glacial till.

Dundas soils are similar to Blomford, Freer, Ronneby, and Webster soils and are usually adjacent to Hayden and Bluffton soils. Webster soils have mollic epipedons. Blomford soils formed in a moderately thick sandy mantle over glacial till. Freer soils formed in silty sediments and the underlying reddish sandy loam till. Ronneby soils formed in reddish sandy loam till. Hayden soils are well drained and are in the more sloping areas. Bluffton soils are very poorly drained and are in the lower depressions.

Typical pedon of Dundas fine sandy loam, 120 feet east and 1,430 feet north of the southwest corner of section 27, T. 32 N., R. 21 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) fine sandy loam, gray (10YR 6/1) dry; weak very fine granular structure; friable; about 4 percent coarse fragments; medium acid; abrupt smooth boundary.

A2—9 to 13 inches; grayish brown (10YR 5/2) sandy clay loam, light gray (10YR 7/2) dry; common medium prominent strong brown (7.5YR 5/6) and yellowish red (5YR 4/6) mottles; weak medium platy structure; firm; about 4 percent coarse fragments; medium acid; clear smooth boundary.

B1tg—13 to 20 inches; grayish brown (2.5Y 5/2) sandy clay loam; many fine prominent dark reddish brown (5YR 3/4) and strong brown (7.5YR 5/6) mottles; moderate fine and medium subangular blocky structure; firm; few thin clay films on horizontal faces of peds; few thin coatings of clean sand and silt particles on vertical faces of peds; about 4 percent coarse fragments; medium acid; clear smooth boundary.

B21tg—20 to 29 inches; grayish brown (2.5Y 5/2) sandy clay loam; many fine and medium prominent dark reddish brown (5YR 3/4) mottles; weak and moderate medium and coarse prismatic structure parting to moderate medium and thick platy and weak medium subangular blocky; firm; few thin and moderately thick clay films on faces of peds; common thin and moderately thick coatings of clean sand and silt particles on faces of prisms; few thin black coatings of manganese dioxide on faces of secondary peds; about 4 percent coarse fragments; medium acid; clear smooth boundary.

B22tg—29 to 38 inches; grayish brown (2.5Y 5/2) sandy clay loam; many fine faint light olive brown (2.5Y 5/4) and few fine prominent dark red (2.5YR 3/6) mottles; moderate medium and coarse prismatic structure parting to moderate medium angular blocky; firm; many thin and moderately thick clay films on faces of peds and in pores; few thin coatings of clean sand and silt particles on faces of prisms; about 4 percent coarse fragments; slightly acid; gradual smooth boundary.

B3tg—38 to 45 inches; grayish brown (2.5Y 5/2) sandy clay loam; many fine and medium faint light olive brown (2.5Y 5/4) and common fine prominent dark red (2.5YR 3/6) mottles; weak medium subangular blocky structure parting to weak very fine angular blocky; firm; few thin through thick clay films on faces of peds and in root channels and pores; about 4 percent coarse fragments; neutral; clear smooth boundary.

C1g—45 to 53 inches; grayish brown (2.5Y 5/2) loam; many fine and medium faint light olive brown (2.5Y 5/6) mottles; weak medium and thick platy structure; friable; few clayey fillings in root channels and on cleavage faces; few black coatings of manganese dioxide on faces of peds; about 1 percent fine soft whitish limy masses; about 4 percent coarse fragments; moderately alkaline; slight effervescence; gradual smooth boundary.

C2g—53 to 60 inches; grayish brown (2.5Y 5/2) loam; many fine and medium faint light olive brown (2.5Y 5/6) mottles; massive; friable; about 5 percent fine and medium soft whitish limy masses; about 4 percent coarse fragments; moderately alkaline; strong effervescence.

The thickness of the solum and depth to free carbonates range from 30 to 48 inches. The solum typically is 1 to 8 percent coarse fragments. The reaction of the solum is medium acid or slightly acid in the upper part and slightly acid or neutral in the lower part. The C horizon is mildly alkaline to moderately alkaline.

The Ap or A1 horizon has value of 2 or 3 and chroma of 1. The Ap or A1 horizon typically is fine sandy loam, but loam is within the range. The A2 horizon has value of 4 or 5 and chroma of 1 or 2. It is sandy clay loam, fine sandy loam, sandy loam, or loam. The B horizon has hue of 2.5Y or 5Y, value or 4 or 5, and chroma of 2 or 3. Faint to distinct mottles are in most of the B horizon.

The texture typically is sandy clay loam but includes clay loam. Bleached, grainy, silty, and sandy coatings of A2 material surround peds in the B21 horizon of some pedons. Clay films are continuous to patchy. The C horizon has hue of 2.5Y or 5Y, value is dominantly 5, and chroma is 2 or 3. The texture is fine sandy loam or loam.

Emmert series

The Emmert series consists of excessively drained, very rapidly permeable soils on outwash plains. They formed in noncalcareous sand and gravelly sand outwash. Slope ranges from 3 to 25 percent.

Emmert soils are similar to Anoka, Gotham, Hubbard, Mahtomedi, and Zimmerman soils and are commonly adjacent to Chetek, Kingsley, and Rosholt soils on the landscape. All of these soils, except the Kingsley soils, formed in glacial outwash and are less than 35 percent coarse fragments. In addition, the Chetek and Rosholt soils have a thicker loamy mantle than the Emmert soils. The Kingsley soils formed in glacial till.

Typical pedon of Emmert gravelly loamy coarse sand, 15 to 25 percent slopes, 1,720 feet east and 1,260 feet north of the southwest corner of section 1, T. 31 N., R. 20 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) gravelly loamy coarse sand, brown (10YR 5/3) dry; weak fine granular structure; very friable; about 15 percent coarse fragments; strongly acid; abrupt smooth boundary.

B21—6 to 12 inches; brown (7.5YR 4/4) gravelly coarse sand, light yellowish brown (10YR 6/4) dry; single grain; loose; about 50 percent coarse fragments; medium acid; clear smooth boundary.

B22—12 to 24 inches; brown (7.5YR 4/4) gravelly coarse sand; single grain; loose; about 50 percent coarse fragments; slightly acid; clear smooth boundary.

C1—24 to 36 inches; reddish brown (5YR 5/4) gravelly coarse sand; single grain; loose; about 40 percent coarse fragments; slightly acid; clear smooth boundary.

C2—36 to 60 inches; reddish brown (5YR 4/4) gravelly coarse sand; single grain; loose; about 70 percent coarse fragments; neutral.

The thickness of the solum ranges from 12 to 28 inches. Free carbonates are lacking to a depth of 4 feet or more. The control section commonly is 45 to 60 percent coarse fragments. The reaction of the solum is slightly acid to strongly acid.

The A1 or Ap horizon has value of 2 through 4 and chroma of 1 or 2. It is gravelly loamy coarse sandy, loamy coarse sand, loamy sand, fine sandy loam, or sandy loam. Some pedons have a thin, grayish A2 horizon. The B horizon has hue of 7.5YR or 5YR and value and chroma of 3 or 4. It is sand, loamy sand, loamy coarse sand, or coarse sand. The C horizon has hue of 5YR or 7.5YR, value of 3 through 5, and chroma of 3 through 6. It is coarse sand or sand, and stratification is common. The C horizon ranges from strongly acid to neutral.

Faxon series

The Faxon series consists of poorly drained and very poorly drained, moderately permeable soils on terraces or benches. These soils formed in 20 to 40 inches of loamy glacial drift over sandstone or limestone bedrock.

Faxon soils are similar to Webster soils and are commonly adjacent to Copaston soils. The well drained Copaston soils are on higher and/or more sloping terrain and are less than 20 inches deep to bedrock. The Webster soils are poorly drained and lack a lithic contact within 40 inches of the surface.

Typical pedon of Faxon silt loam, 300 feet south and 250 feet west of the northeast corner of section 25, T. 32 N., R. 20 W.

A11—0 to 7 inches; black (10YR 2/1) silt loam; weak coarse granular structure; friable; neutral; clear smooth boundary.

A12—7 to 13 inches; black (10YR 2/1) silt loam; moderate medium granular structure; friable; neutral; clear smooth boundary.

A13—13 to 19 inches; black (10YR 2/1) silt loam; many medium distinct brown (7.5YR 5/4) mottles; moderate medium granular structure; friable; neutral; clear wavy boundary.

B21g—19 to 27 inches; greenish gray (5GY 6/1) silt loam; common medium prominent reddish yellow (7.5YR 6/6), yellowish red (5YR 5/6), and yellowish brown (10YR 5/6) mottles; weak medium angular and subangular blocky structure; friable; neutral; clear wavy boundary.

B22g—27 to 34 inches; greenish gray (5GY 6/1) silt loam; few medium distinct brownish yellow (10YR 6/6) and few fine faint greenish gray (5BG 6/1) mottles; massive; friable; neutral; clear smooth boundary.

IIR—34 to 60 inches; pale brown (10YR 6/3) and very pale brown (10YR 7/3) sandstone bedrock.

Thickness of the solum and depth to bedrock range from 20 to 40 inches. Free carbonates are in at least some part of the A horizon and in some pedons are in a part of the B horizon. Reaction is neutral to mildly alkaline throughout the solum. The mollic epipedon is 10 to 20 inches thick.

The O horizon up to 6 inches thick is in some pedons. The A horizon has hue of 10YR through 5Y, value of 2 or 3, and chroma of 1, or it is N 2/0 or N 3/0. It is loam, silt loam, clay loam, or sandy clay loam. The B horizon has a matrix with hue of 2.5Y, 5Y, or 5GY; value of 4 through 6; chroma of 1 or 2 in the upper part and 1

through 4 in the lower part; or it is N 4/0 or N 5/0. The B horizon is sandy loam, loam, sandy clay loam, silt loam, or clay loam.

Freeon series

The Freeon series consists of moderately well drained soils that formed in 15 to 30 inches of silty sediments and the underlying loamy glacial till. Permeability is moderate through the surface layer and upper part of the subsoil and is moderately slow through the lower part of the subsoil and the underlying material. Slope ranges from 1 to 4 percent.

As mapped in Washington and Ramsey Counties, the Freeon soils have lower chroma mottles in the upper 10 inches than is defined as the range for the series. This difference, however, does not alter their usefulness or behavior.

Freeon soils are similar to Crystal Lake and Ronneby soils and are commonly adjacent to Freer, Kingsley, and Prebish soils. Crystal Lake soils formed entirely in silty lacustrine material. Ronneby and Freer soils are somewhat poorly drained and are in depressions. Kingsley soils are well drained and are in more sloping areas than Freeon soils. Prebish soils are very poorly drained.

Typical pedon of Freeon silt loam, 1 to 4 percent slopes, 1,300 feet south and 1,080 feet east of the northwest corner of section 28, T. 29 N., R. 21 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, light brownish gray (10YR 6/2) dry; weak very fine and fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A2—8 to 12 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; weak very fine and fine platy structure; very friable; medium acid; clear smooth boundary.

B1—12 to 18 inches; dark yellowish brown (10YR 4/4) silt loam; weak fine and medium subangular blocky structure; friable; thin and medium continuous coatings of clean sand and silt particles; medium acid; clear smooth boundary.

B21t—18 to 24 inches; yellowish brown (10YR 5/4) silt loam; few fine faint grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; firm; few thin clay films on horizontal faces of peds and in pores; many thin coatings of clean sand and silt particles on vertical faces of peds; strongly acid; clear smooth boundary.

B22t—24 to 30 inches; dark brown (7.5YR 4/4) silt loam; common fine faint strong brown (7.5YR 5/6) mottles; very weak medium prismatic structure parting to strong fine and medium subangular blocky; friable; many thin clay films on horizontal faces of peds and in pores; many thin coatings of clean sand and silt particles on vertical faces of peds; strongly acid; abrupt smooth boundary.

IIB23t—30 to 38 inches; reddish brown (5YR 4/4) sandy loam; moderate thin through thick platy structure; firm; many thin and medium dark brown (7.5YR 3/2) clay films on vertical cleavages and many thin reddish brown (5YR 4/4) clay films on faces of plates; about 10 percent coarse fragments; thin strata of silt loam in lower part; medium acid; abrupt smooth boundary.

IIB3—38 to 54 inches; reddish brown (5YR 4/4) sandy loam; weak medium and thick platy structure; firm; common thin dark reddish brown (5YR 3/4) clay films on faces of plates; about 10 percent coarse fragments; slightly acid; gradual smooth boundary.

IIC—54 to 60 inches; reddish brown (5YR 4/4) sandy loam; weak thin platy structure; friable; about 10 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 24 to 54 inches. Thickness of the silty material ranges from 15 to 30 inches. Coarse fragments are less than 5 percent of the volume of the A horizon and upper part of the B horizon and 8 to 20 percent of the volume in the IIB and IIC horizons.

The Ap horizon has value of 3 through 5 and chroma of 1 through 3. The A2 horizon has value of 4 or 5 and chroma of 2 or 3. In some pedons the A2 horizon extends into the B horizon as tongues. The upper B1 and B2 horizons have hue of 5YR, 7.5YR, or 10YR, value of 4 through 6, and chroma of 3 through 5. Mottles range from distinct to faint in these horizons. They are silt loam or light silty clay loam. The IIB2t and IIB3 horizons have hue of 2.5YR or 5YR and value and chroma of 3 through 5. They are loam or sandy loam. They range from slightly acid to strongly acid. The IIC horizon is dominantly sandy loam or fine sandy loam. It has hue of 2.5YR or 5YR and value and chroma of 3 through 5. Reaction is medium acid to neutral.

Freer series

The Freer series consists of somewhat poorly drained soils that formed in 15 to 30 inches of silty sediments and the underlying loamy glacial till. Permeability is moderate in the silty mantle and moderately slow in the underlying materials. Slope ranges from 0 to 2 percent.

Freer soils are similar to Comstock and Ronneby soils and are commonly adjacent to Santiago and Freeon soils. Comstock soils formed entirely in silty lacustrine sediments. Ronneby soils lack the silty surface layer. Santiago soils are well drained. Freeon soils are moderately well drained and are in more sloping areas than Freer soils.

Typical pedon of Freer silt loam, 1,060 feet south and 320 feet east of the northwest corner of section 28, T. 29 N., R. 21 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak

medium granular structure; friable; slightly acid; abrupt smooth boundary.

A2—8 to 12 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; common medium distinct strong brown (7.5YR 5/6) and fine distinct dark brown (7.5YR 4/2) mottles; weak thin and medium platy structure; friable; medium acid; abrupt irregular boundary.

B&A—12 to 17 inches; brown (10YR 5/3) silt loam (B2t); common medium distinct strong brown (7.5YR 5/6) and dark brown (7.5YR 4/2) mottles; weak medium and thick platy structure parting to moderate fine angular and subangular blocky; grayish brown (10YR 5/2) interfingers of silt loam (A2) are about 20 percent of the matrix; friable; strongly acid; clear smooth boundary.

B21t—17 to 23 inches; grayish brown (10YR 5/2) loam; common medium distinct yellowish red (5YR 4/6) and gray (5YR 6/1) mottles; weak fine prismatic structure parting to moderate fine and medium subangular blocky; friable; few patchy porous grainy coats and thin patchy clay films on ped faces; strongly acid; clear smooth boundary.

IIB22t—23 to 37 inches; reddish gray (5YR 5/2) sandy loam; many coarse faint reddish brown (5YR 4/3) and yellowish red (5YR 5/8) mottles; weak very thick platy structure; firm; common thin clay films on vertical surfaces; few soft iron manganese concretions; slightly acid; gradual smooth boundary.

IIC—37 to 60 inches; reddish brown (5YR 4/4) sandy loam; few fine faint yellowish red (5YR 5/6) mottles; weak thick platy structure; firm; slightly acid.

Thickness of the solum ranges from 36 to 54 inches. Thickness of the silty layer ranges from 15 to 30 inches. Coarse fragments are 1 to 4 percent by volume of the silty layer and 8 to 20 percent of the IIB and IIC horizons.

The Ap horizon has value of 2 or 3 and chroma of 2. The A2 horizon has value of 4 or 5 and chroma of 1 or 2. The A horizon typically is silt loam, but very fine sandy loam and loam high in content of silt are within the range. The A horizon is strongly acid to slightly acid. The A2 horizon extends into the B horizon as interfingers. The upper part of the B1 and B2 horizons has hue of 5YR, 7.5YR, or 10YR; value of 4 or 5; and chroma of 2 through 6. These horizons are silt loam, loam, or silty clay loam and are strongly acid. Clay films range from few to common and thin to medium. The IIB horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 2 through 5. It is sandy loam, fine sandy loam, or loam. The IIC horizon has hue or 2.5Y or 5YR and value and chroma of 3 through 5. It is sandy loam or fine sandy loam and is slightly acid to neutral.

Gale series

The Gale series consists of well drained soils on loess mantled uplands. They formed in 18 to 36 inches of loess and the underlying material weathered from sandstone bedrock. Permeability is moderate. Slope ranges from 6 to 50 percent.

Gale soils are similar to the Baytown, Channahon, Ripon, and Whalan soils and are commonly adjacent to Baytown, Copaston, and Ostrander soils. Baytown soils occupy slightly lower, plane to slightly concave slopes, and have darker colored surface horizons than Gale soils. Channahon soils have a darker colored surface layer and are over limestone bedrock. Whalan soils formed in 20 to 40 inches of loamy sediments over limestone. Copaston soils formed in a 12- to 20-inch loamy mantle over hard sandstone or limestone bedrock and are slightly higher on the landscape. Ripon soils formed in a silty mantle over limestone bedrock. Ostrander soils, in similar positions on the landscape, formed in silt mantled glacial till.

Typical pedon of Gale silt loam, 6 to 15 percent slopes, 1,980 feet north and 265 feet west of the southeast corner of section 32, T. 28 N., R. 20 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

B1—8 to 12 inches; dark brown (10YR 4/3) silt loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; friable; slightly acid; clear wavy boundary.

B21t—12 to 20 inches; dark yellowish brown (10YR 4/4) silt loam; strong moderate subangular blocky structure; firm; very few thin very dark grayish brown (10YR 3/2) clay films on ped faces; medium acid; clear wavy boundary.

B22t—20 to 26 inches; dark yellowish brown (10YR 4/4) silt loam; strong moderate subangular blocky structure; firm; very few thin very dark grayish brown (10YR 3/2) clay films on ped faces; medium acid; clear wavy boundary.

IIB3—26 to 30 inches; yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) fine sandy loam; massive; firm; slightly acid; abrupt wavy boundary.

R—30 to 60 inches; white (10YR 8/2) and brownish yellow (10YR 6/8) sandstone bedrock.

Solum thickness ranges from 20 to 34 inches, and the silty mantle ranges from 18 to 32 inches thick. Sandstone, commonly soft but with some hard layers, is at a depth of 20 to 40 inches. The surface layer is strongly acid to neutral, and the B and IIC horizons are slightly acid to strongly acid. The surface layer is neutral where limed.

The Ap or A1 horizon has value of 3 through 5 and chroma of 2 or 3. The A2 horizon is in some pedons. The A horizon typically is silt loam or loam high in silt. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is silt loam or silty clay loam. The IIB3 horizon has hue of 10YR or 7.5YR and value

and chroma of 4 through 6. It is loam, sandy loam, fine sandy loam, loamy fine sand, or loamy very fine sand. Some pedons have a IIC horizon. Typically, the sandstone has hue of 10YR or 7.5YR, value of 5 through 8, and chroma of 2 through 6. It commonly has a hardness of less than 3 (Mohs scale) in the upper 12 to 18 inches.

Gotham series

The Gotham series consists of well drained, rapidly permeable soils on outwash plains. They formed in loamy sand or sand 4 or more feet thick. Slope ranges from 1 to 20 percent.

Gotham soils are similar to Anoka and Zimmerman soils and are commonly adjacent to the Anoka, Chetek, Demontreville, Mahtomedi, and Zimmerman soils. The Anoka soils occupy similar positions to Gotham soils, but formed in fine and very fine sand. The Chetek soils formed in loamy material over stratified sand and gravel. The Demontreville soils are on more rolling topography and formed in sandy mantled glacial till. Mahtomedi soils formed in medium to coarse sand and gravel outwash. The Zimmerman soils formed in fine sand and have thinner Bt bands than Gotham soils.

Typical pedon of Gotham loamy sand, 1 to 6 percent slopes, 660 feet west and 660 feet south of the northeast corner of section 36, T. 32 N., R. 21 W.

Ap—0 to 9 inches; dark brown (7.5YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A2—9 to 20 inches; dark brown (7.5YR 4/2) loamy sand, light brownish gray (10YR 6/2) dry; moderate very thick platy structure parting to weak medium subangular blocky; friable; slightly acid; clear wavy boundary.

B21t—20 to 28 inches; brown (7.5YR 4/4) loamy sand; weak very thick platy structure parting to weak medium and coarse subangular blocky; friable; dark reddish brown (5YR 3/4) thin clay films as bridges between sand grains and lining tubular or interstitial pores; slightly acid; gradual wavy boundary.

B22t—28 to 33 inches; brown (7.5YR 4/4) loamy sand; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

C1—33 to 44 inches; brown (7.5YR 5/4) sand; single grain; loose; slightly acid; clear smooth boundary.

C2—44 to 60 inches; brown (7.5YR 5/4) loamy sand; single grain; loose; slightly acid.

The solum thickness ranges from 24 to 40 inches. In some pedons subhorizons are 2 to 15 percent coarse fragments.

The Ap or A1 horizon has hue of 10YR or 7.5YR, value of 2 through 4, and chroma of 2 or 3. It typically is loamy sand or loamy fine sand. Some pedons do not have an A2 horizon. The B2 horizon has hue of 7.5YR, value of 4 and 5, and chroma of 4 through 6. The C horizon has hue of 10YR or 7.5YR and value and chroma of 4 through 6. It is loamy sand, sand, or coarse sand.

Grays series

The Grays series consists of moderately well drained, moderately permeable soils on glacial lake plains. They formed in lacustrine silty material. Slope ranges from 2 to 6 percent.

The Grays soils, as mapped in Washington and Ramsey Counties, are outside the range defined for the series in that they have more albic material in the upper part of the argillic horizon and have a slightly thicker solum. These differences, however, do not alter their usefulness or behavior.

Grays soils are similar to Campia soils and are commonly adjacent to Barronett soils. Barronett soils are poorly drained and are lower on the landscape. Campia soils formed in noncalcareous silty eolian and lacustrine sediments.

Typical pedon of Grays silt loam, 2 to 6 percent slopes, 1,155 feet east and 960 feet south of the northwest corner of section 5, T. 29 N., R. 22 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak coarse and medium granular structure; friable; neutral; abrupt smooth boundary.

A2—8 to 11 inches; grayish brown (10YR 5/2) silt loam, light brownish gray (10YR 6/2) dry; weak medium platy structure; friable; slightly acid; clear wavy boundary.

B&A—11 to 16 inches; 70 percent dark brown (10YR 4/3) silty clay loam (B2t); grayish brown (10YR 5/2) silt loam (A) makes up about 30 percent of the matrix and extends as interfingers into the B2t horizon; moderate fine platy structure; friable; medium acid; clear smooth boundary.

B21t—16 to 30 inches; dark brown (10YR 4/3) silty clay loam; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; many moderately thick and thick very dark gray (10YR 3/1) clay films on ped faces and in pores; strongly acid; clear smooth boundary.

B22t—30 to 48 inches; brown (10YR 5/3) silty clay loam; common medium distinct yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; many moderately thick and thick very dark gray (10YR 3/1) clay films on ped faces and in pores; medium acid; clear smooth boundary.

C—48 to 60 inches; brown (10YR 5/3) silt loam; common medium distinct dark brown (7.5YR 6/2) mottles; weak very thick platy structure; friable; few moderately thick and thick very dark gray (10YR 3/1) clay films in pores in upper part of horizon;

slightly calcareous; lime segregated in rounded medium sized soft masses; mildly alkaline.

The solum commonly extends beyond the depth to carbonates; in some places solum thickness and depth to carbonates are the same. Depth to carbonates typically is 25 to 35 inches but ranges from 20 to 50 inches.

The A1 or Ap horizon has value of less than 3.5 and chroma of 1, 2, or 3. The A2 horizon has value of 4 or 5 and chroma of 2 or 3. The A horizon is silt loam or very fine sandy loam high in silt. The Bt horizon has hue of 10YR or 7.5YR; value of 4 or 5; and chroma of 3 through 6. It is silty clay loam or silt loam. The C horizon commonly is calcareous, stratified silt loam, loam, and fine sandy loam. The C horizon has hue of 10YR or 2.5Y; value of 4 through 6; and chroma of 2 through 4.

Hayden series

The Hayden series consists of well drained, moderately permeable soils on ground moraines. They formed in calcareous loamy glacial till. Slope ranges from 2 to 25 percent.

Hayden soils are similar to Braham and Duluth soils and commonly are adjacent to Nessel, Dundas, and Bluffton soils. Braham soils formed in a 20- to 40-inch sandy mantle and the underlying loamy glacial till. Duluth soils formed in reddish noncalcareous loamy glacial till. Nessel soils are moderately well drained and are in plane or slightly concave areas. Dundas soils are poorly drained and are in depressions. Bluffton soils are very poorly drained and are in depressions or along drainageways.

Typical pedon of Hayden fine sandy loam, 2 to 6 percent slopes, 720 feet east and 1,780 feet north of the southwest corner of section 27, T. 32 N., R. 21 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) fine sandy loam, light brownish gray (10YR 6/2) dry; weak very fine granular structure; very friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

A2—9 to 15 inches; grayish brown (10YR 5/2) fine sandy loam, pale brown (10YR 6/3) dry; weak medium platy structure; friable; about 2 percent coarse fragments; neutral; clear slightly wavy boundary.

B11—15 to 21 inches; dark yellowish brown (10YR 4/4) sandy loam; moderate fine subangular blocky structure; friable; very few thin clay films in pores; continuous thin coatings of clean sand and silt particles on faces of peds; about 2 percent coarse fragments; neutral; clear smooth boundary.

B12—21 to 28 inches; yellowish brown (10YR 5/4) loam; weak medium prismatic structure parting to moderate medium subangular blocky; firm; continuous thin and medium coatings of clean sand and silt particles on faces of prisms and few thin coatings on faces of secondary peds; few thin clay films on faces of secondary peds; about 2 percent coarse fragments; strongly acid; clear smooth boundary.

B21t—28 to 37 inches; yellowish brown (10YR 5/4) clay loam; moderate medium prismatic structure parting to moderate fine and medium angular blocky; firm; continuous medium and thick very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) clay films on faces of prisms and many thin and medium films on faces of secondary peds; few thin coatings of clean sand and silt particles on faces of prisms in upper part; about 2 percent coarse fragments; slightly acid; gradual smooth boundary.

B22t—37 to 44 inches; yellowish brown (10YR 5/4) clay loam; moderate medium and coarse prismatic structure parting to weak coarse angular blocky; firm; continuous medium very dark grayish brown (10YR 3/2) clay films on faces of prisms and few thin and medium films on faces of secondary peds; about 2 percent coarse fragments; neutral; gradual smooth boundary.

B3t—44 to 50 inches; yellowish brown (10YR 5/4) loam; few fine and medium faint grayish brown (10YR 5/2) mottles; very weak coarse prismatic structure parting to weak medium and thick platy; friable; few thin through thick very dark grayish brown (10YR 3/2) clay films on faces of peds and in root channels; about 2 percent fine soft whitish limy masses; about 5 percent coarse fragments; neutral; slight effervescence; clear smooth boundary.

Cca—50 to 60 inches; yellowish brown (10YR 5/4) grading to light olive brown (2.5Y 5/4) loam; few fine faint grayish and reddish brown mottles; weak thick platy structure; friable; very few thin through thick clayey fillings in old root channels; very few fine black manganese dioxide coatings on faces of plates; about 5 percent fine and medium whitish limy masses mostly on faces of plates; about 5 percent coarse fragments; moderately alkaline, strong effervescence.

Thickness of the solum commonly is 34 to 48 inches but ranges from 24 to 54 inches. The solum is as much as 8 percent coarse fragments.

The Ap and A2 horizons have value of 4 or 5 and chroma of 1 or 2. The A horizon is fine sandy loam, sandy loam, or loam. It is neutral to medium acid. The B2 horizon has value of 4 or 5 and chroma of 3 through 5. It is clay loam, loam, or sandy clay loam and is strongly acid to neutral. Reddish or brownish mottles or stains are in some pedons. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 through 5. The texture is fine sandy loam, sandy loam, or loam. The C horizon is mildly alkaline to moderately alkaline.

Hubbard series

The Hubbard series consists of excessively drained, rapidly permeable soils on outwash plains and in valley trains. They formed in sandy glacial outwash sediments. Slope ranges from 1 to 18 percent.

Hubbard soils are similar to the Burkhardt, Mahtomedi, and Sparta soils. Burkhardt soils have a cambic horizon and a thinner solum. Mahtomedi soils lack a mollic epipedon. Sparta soils have more fine sand throughout and also are in a warmer soil temperature regime than Hubbard soils.

Typical pedon of Hubbard loamy sand, 1 to 6 percent slopes, 650 feet south and 2,145 feet west of the northwest corner of section 2, T. 28 N., R. 20 W.

A1—0 to 15 inches; very dark gray (10YR 3/1) loamy sand, dark grayish brown (10YR 4/2) dry; single grain; loose; slightly acid; clear smooth boundary.
A3—15 to 20 inches; dark brown (10YR 3/2) loamy sand; single grain; loose; medium acid; clear smooth boundary.
B2—20 to 26 inches; dark brown (7.5YR 4/2) sand; single grain; loose; slightly acid; clear smooth boundary.
B3—26 to 35 inches; brown (7.5YR 4/2) sand; single grain; loose; slightly acid; clear smooth boundary.
C1—35 to 40 inches; brown (7.5YR 4/4) sand; single grain; loose; neutral; clear smooth boundary.
C2—40 to 60 inches; brown (7.5YR 4/4) sand; single grain; loose; neutral.

Thickness of the solum ranges from 25 to 50 inches, and the depth to free carbonates is 50 to more than 60 inches. Some pedons have up to 20 percent coarse fragments that are 5 mm or less in size.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It typically is loamy coarse sand, loamy sand, coarse sand, or sand, but in a few places it is sandy loam or coarse sandy loam in the upper 10 inches. The A horizon is strongly acid through neutral. The B horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 2 through 4. It is sand, coarse sand, or loamy sand and is strongly acid through slightly acid. The C horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 2 through 5. Mottles are in some pedons below a depth of 40 inches. The C horizon is coarse sand or sand. It is slightly acid or neutral.

Isanti series

The Isanti series consists of very poorly drained, rapidly permeable soils on outwash plains. They formed in sandy outwash. Slope ranges from 0 to 2 percent.

Isanti soils are similar to Bluffton, Kratka, and Prebish soils and are commonly adjacent to Anoka, Lino, Soderville, and Zimmerman soils. Bluffton and Prebish soils formed entirely in glacial till. Kratka soils formed in a moderately deep sandy mantle over glacial till or lacustrine sediments. Zimmerman and Anoka soils are excessively drained and well drained, respectively, and are on nearby stronger slopes. Lino and Soderville soils are somewhat poorly drained and are slightly higher on the landscape.

Typical pedon of Isanti loamy fine sand, 2,040 feet west and 2,610 feet north of the corner of section 9, T. 31 N., R. 21 W.

A11—0 to 5 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; high in organic matter; weak coarse and medium granular structure; very friable; very strongly acid; abrupt smooth boundary.
A12—5 to 13 inches; black (N 2/) loamy fine sand, very dark gray (10YR 3/1) dry; weak very coarse platy structure parting to weak medium subangular blocky; very friable; very strongly acid; abrupt irregular boundary.
B21—13 to 24 inches; dark gray (10YR 4/1) loamy fine sand; weak medium subangular blocky structure; very friable; very strongly acid; clear wavy boundary.
B22—24 to 42 inches; grayish brown (2.5Y 5/2) fine sand; single grain; loose; strongly acid; clear wavy boundary.
C—42 to 60 inches; gray (5Y 5/1) loamy fine sand; single grain; loose; strongly acid.

The thickness of the solum ranges from 20 to 45 inches. There are no coarse fragments above a depth of 40 inches. Some pedons have an O horizon as much as 6 inches thick.

The A horizon is black (10YR 2/1, 5Y 2/1, or N 2/0) and is mottled in some pedons. It is dominantly loamy fine sand, but the range includes fine sand, sand, loamy sand, fine sandy loam, or sandy loam. Reaction ranges from slightly acid to very strongly acid. Some pedons have an A3 horizon. The B horizon has hue of 10YR, 2.5YR, 5Y, or neutral; value of 4 or 5; and chroma of 1 or 2. Mottles are common in the B horizon. It is fine sand, sand, loamy fine sand, or loamy sand and ranges from slightly acid to very strongly acid. The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 or 6; and chroma of 1 or 2. It typically is fine sand, sand, loamy sand, or loamy fine sand. Reaction ranges from strongly acid to slightly acid.

Kerston series

The Kerston series consists of very poorly drained soils that formed in stratified organic and mineral materials. These soils are on flood plains. Permeability is moderate or moderately rapid. Slope is less than 1 percent.

Kerston soils are similar to the Cathro, Markey, Rifle, and Seelyeville soils. Cathro soils formed in less than 51 inches of organic soil materials over loamy mineral material. Markey soils formed in less than 51 inches of organic soil material over sandy mineral material. The Rifle

and Seelyeville soils formed in deep organic soil materials.

Typical pedon of Kerston muck, 2,145 feet east and 1,750 feet north of the southwest corner of section 14, T. 28 N., R. 22 W.

Oa1—0 to 9 inches; black sapric material, (N 2/0 broken face and 10YR 2/1 rubbed); less than 10 percent fiber unrubbed and rubbed; weak medium granular structure; very friable; slightly acid; abrupt smooth boundary.

Oa2—9 to 20 inches; black (10YR 2/1) sapric material broken face and rubbed; about 30 percent unrubbed fiber, less than 5 percent rubbed; weak medium subangular blocky structure; very friable; slightly acid; abrupt smooth boundary.

IIC1—20 to 24 inches; black (10YR 2/1) silt loam; massive; friable; slightly acid; abrupt smooth boundary.

IIOe1—24 to 32 inches; hemic material; dark reddish brown (5YR 3/4) broken face, black (N 2.5/0) rubbed; about 70 percent unrubbed fiber, about 35 percent rubbed fiber; massive; very friable; medium acid; abrupt smooth boundary.

IIC2—32 to 38 inches; black (10YR 2/1) mucky silt loam; massive; very friable; about 20 percent organic matter content; medium acid; abrupt smooth boundary.

IIOa3—38 to 50 inches; sapric material dark brown (10YR 3/3) broken face, very dark gray (10YR 3/1) rubbed; about 45 percent fiber unrubbed, less than 5 percent rubbed; massive; very friable; medium acid; abrupt smooth boundary.

IIC3—50 to 58 inches; black (10YR 2/1) mucky silt loam; massive; very friable; about 15 percent unrubbed fiber; neutral; abrupt smooth boundary.

IIOa4—58 to 60 inches; very dark gray (10YR 3/1) broken face, black (10YR 2/1) rubbed sapric material; about 30 percent unrubbed fiber, less than 5 percent rubbed fiber; massive; very friable; neutral.

The depth to the first mineral layer ranges from 12 to 40 inches. The surface tier is typically well decomposed sapric material derived from herbaceous material. Thickness and sequence of the layers of organic material vary greatly in these soils. The mineral IIC horizon is 2 to 12 inches thick and constitutes less than 50 percent of the upper 32 inches of the profile. The mineral IIC horizon has hue of 10YR, value of 2 through 4, and chroma of 1 or 2. The IIC horizon ranges from fine sand to silty clay loam but dominantly is silt loam. Reaction of the profile ranges from medium acid to neutral.

Kingsley series

The Kingsley series consists of well drained, moderately slowly permeable soils on end moraines. They formed in loamy glacial till. Slope ranges from 2 to 30 percent.

Kingsley soils are similar to Demontreville, Duluth, Hayden, and Santiago soils and are commonly adjacent to Freeon, Ronneby, and Prebish soils. Demontreville soils formed in a 20- to 40-inch sandy mantle and the underlying loamy till. Duluth soils formed in loamy glacial till. Hayden soils formed in calcareous loamy till. Santiago soils formed in 15 to 30 inches of loess and the underlying glacial till. Freeon soils are moderately well drained and are in the lower, less sloping areas. Ronneby soils are in depressions and are somewhat poorly drained. Prebish soils are very poorly drained and are in depressions.

Typical pedon of Kingsley sandy loam, 2 to 6 percent slopes, 1,400 feet east and 1,020 feet south of the northwest corner of section 28, T. 29 N., R. 21 W.

Ap—0 to 8 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; weak very fine granular structure; friable; plentiful very fine and fine roots; about 15 percent coarse fragments; medium acid; abrupt smooth boundary.

B1t—8 to 12 inches; reddish brown (5YR 4/4) sandy loam, dark brown (7.5YR 4/4) dry; weak fine and medium subangular blocky structure; firm; many thin and medium coatings of clean sand and silt particles on faces of peds, thicker coatings on vertical faces; very few thin dark reddish brown (5YR 3/4) clay films; plentiful very fine and fine roots; about 15 percent coarse fragments; medium acid; clear smooth boundary.

B21t—12 to 19 inches; reddish brown (5YR 4/4) sandy loam; moderate medium and coarse subangular blocky structure; firm; very few thin coatings of clean sand and silt particles on faces of peds; many thin dark reddish brown (5YR 3/4) clay films on faces of peds; few very fine and fine roots; about 15 percent coarse fragments; medium acid; gradual smooth boundary.

B22t—19 to 26 inches; reddish brown (5YR 4/4) sandy loam; weak thick platy structure with enough vertical cleavage planes to suggest very weak coarse prismatic structure; firm; common thin dark reddish brown (5YR 3/4) clay films on faces of plates and on vertical faces; very few fine roots; about 15 percent coarse fragments; medium acid; diffuse smooth boundary.

B3t—26 to 39 inches; reddish brown (5YR 4/4) sandy loam; weak medium through very thick platy structure with enough vertical cleavage planes to suggest very weak coarse prismatic structure; firm; few thin dark reddish brown (5YR 3/4) clay films on faces of peds; about 15 percent coarse fragments; medium acid; diffuse smooth boundary.

C—39 to 60 inches; reddish brown (5YR 4/4) sandy loam; weak medium through very thick platy structure; firm; few vertical cleavage faces; about 15 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 30 to 45 inches. The profile is commonly 5 to 20 percent coarse fragments.

The Ap horizon has value of 3 and chroma of 2 or 3. If there is an A1 horizon, it has lower value and chroma than the Ap horizon. In uncultivated areas some pedons have an A2 horizon. The A horizon is fine sandy loam, sandy loam, coarse sandy loam, loam, loamy sand, or loamy coarse sand. It is slightly acid or medium acid. The B horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. It typically is sandy loam or coarse sandy loam, but thin sandy clay loam or loamy sand subhorizons are in some pedons. Coatings of grayish A2 material are common in the upper part of the B horizon. The B horizon is hard or very hard when dry and is strongly acid or medium acid. The C horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. It is sandy loam or coarse sandy loam and is hard or very hard when dry. Reaction is medium acid through neutral.

Kratka series

The Kratka series consists of poorly drained soils on sand mantled ground moraine. They formed in a mantle of sandy material over loamy glacial till or lacustrine sediments. These soils have rapid permeability in the upper part and moderately slow permeability in the lower part. Slope ranges from 0 to 2 percent.

Kratka soils are similar to Isanti soils and are commonly adjacent to Blomford and Braham soils. Isanti soils lack loamy materials. Blomford soils are poorly drained, have a lighter colored surface layer than Kratka soils, and have an argillic horizon. Braham soils are well drained and are in convex, more sloping positions on the landscape.

Typical pedon of Kratka fine sandy loam, 2,300 feet west and 1,840 feet south of the northeast corner of section 7, T. 32 N., R. 21 W.

A1—0 to 11 inches; black (10YR 2/1) fine sandy loam, black (10YR 2.5/1) dry; very few fine distinct dark reddish brown (5YR 3/3) mottles; weak fine granular structure; very friable; plentiful roots; about 2 percent coarse fragments; medium acid; clear smooth boundary.

A3—11 to 14 inches; very dark gray (10YR 3/1) and dark gray (10YR 4/1) loamy fine sand; few fine faint brown (7.5YR 4/4) mottles; weak thick platy structure; very friable; few roots; about 2 percent coarse fragments; medium acid; clear smooth boundary.

B2—14 to 29 inches; light brownish gray (2.5Y 6/2) fine sand; common medium distinct brownish yellow (10YR 6/6) and yellowish brown (10YR 5/6) mottles; single grain; loose; few roots; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

IIC1—29 to 33 inches; olive gray (5Y 5/2) fine sandy loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; few roots; about 8 percent coarse fragments; neutral; clear smooth boundary.

IIC2—33 to 60 inches; gray (5Y 5/1) sandy clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 5 percent coarse fragments; mildly alkaline.

The solum ranges from 12 to 40 inches thick. Depth to free carbonates and to the loamy IIC horizon ranges from 20 to 40 inches. A thin lag line or pebble band commonly separates the two sediments.

The A horizon has value of 2 or 3 and chroma of 1 or it is N 2/0. It is gravelly fine sandy loam or loamy fine sand, but loamy sand, sandy loam, and very fine sandy loam are within the range. It is medium acid to slightly acid. The B horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 1 or 2. It has faint to prominent mottles. The B horizon is loamy fine sand, fine sand, loamy sand, or sand. It ranges from slightly acid in the upper part to neutral in the lower part. Some pedons have a thin IIB horizon. The IIC horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 or 6; and chroma of 1 or 2. Texture commonly is sandy clay loam or fine sandy loam but ranges to sandy loam, silt loam, silty clay loam, or loam. The IIC horizon is neutral to mildly alkaline.

Lindstrom series

The Lindstrom series consists of well drained, moderately permeable soils on plane to slightly concave foot slopes of loess covered uplands. They formed in noncalcareous silty sediments eroded from upland soils that formed in loess. Slope ranges from 2 to 4 percent.

Lindstrom soils are similar to the Otter soils. Otter soils are poorly drained and are commonly in lower positions on the landscape.

Typical pedon of Lindstrom silt loam, 2 to 4 percent slopes, 2,200 feet north and 1,300 feet east of the southwest corner of section 24, T. 27 N., R. 21 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A12—9 to 17 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine platy structure parting to weak fine subangular blocky; friable; slightly acid; gradual smooth boundary.

A13—17 to 33 inches; very dark gray (10YR 3/1) silt loam; weak fine and medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A3—33 to 37 inches; very dark grayish brown (10YR 3/2) silt loam; weak fine and medium subangular blocky structure; friable; medium acid; abrupt wavy boundary.

B1—37 to 48 inches; dark yellowish brown (10YR 4/4) silt loam; weak fine and medium subangular blocky

structure; friable; slightly acid; gradual wavy boundary.
B2—48 to 58 inches; yellowish brown (10YR 5/4) silt loam; weak fine and medium subangular blocky structure; friable; slightly acid; gradual wavy boundary.
C—58 to 60 inches; yellowish brown (10YR 5/4) silt loam; few fine and medium distinct strong brown (7.5YR 5/6) mottles and common fine faint grayish brown (10YR 5/2) mottles; moderate fine and medium subangular blocky structure; friable; neutral.

The solum thickness and the depth to free carbonates range from 50 to more than 60 inches. The mollic epipedon ranges from 24 to 54 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is silt loam or loam high in content of very fine sand and is medium acid to neutral. The B horizon has value of 3 through 5 and chroma of 3 or 5. It is medium acid or slightly acid. The C horizon has value of 4 or 5 and chroma of 3 or 4. It is silt loam, loam, or very fine sandy loam and is neutral or mildly alkaline.

Lino series

The Lino series consists of somewhat poorly drained, rapidly permeable soils on glacial outwash plains. They formed in sandy sediments of eolian origin. Slope ranges from 0 to 3 percent.

Lino soils are similar to Soderville soils and are commonly adjacent to Anoka, Isanti, and Zimmerman soils. Anoka soils are well drained and are in elevated positions on the landscape. Isanti soils are very poorly drained and are in depressions and drainageways. Soderville soils have argillic horizons. Zimmerman soils are excessively drained and are on convex side slopes.

Typical pedon of Lino loamy fine sand, 750 feet east and 2,610 feet south of the northwest corner of section 4, T. 31 N., R. 21 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loamy fine sand, brown (10YR 5/3) dry; weak fine and very fine subangular blocky structure; very friable; plentiful roots; very strongly acid; abrupt smooth boundary.
B21—9 to 17 inches; pale brown (10YR 6/3) loamy fine sand, very pale brown (10YR 7/3) dry; common fine distinct dark brown (7.5YR 4/4), yellowish brown (10YR 5/6), and dark reddish brown (5YR 3/4) mottles; single grain; loose; few roots; krotovinas common; very strongly acid; clear smooth boundary.
B22—17 to 36 inches; light brownish gray (10YR 6/2) loamy fine sand; many medium distinct strong brown (7.5YR 5/6) mottles; single grain; loose; few roots; strongly acid; gradual smooth boundary.
C—36 to 60 inches; light brownish gray (10YR 6/2) fine sand; many coarse prominent dark reddish brown (5YR 3/4), dark brown (7.5YR 4/4), and reddish yellow (7.5YR 6/8) mottles; single grain; loose; strongly acid.

Thickness of the solum ranges from 25 to 50 inches. The solum ranges from medium acid to very strongly acid.

The Ap horizon has value of 4 and chroma of 1 or 2. Undisturbed pedons have an A1 horizon slightly lower in value, and some pedons have an A2 horizon. The A horizon is loamy fine sand or fine sand. The B horizon has value of 4 through 6 and chroma of 2 or 3. Mottles with chroma of 2 or less are above a depth of 40 inches in some pedons. The B horizon is loamy fine sand, fine sand, sand, or loamy sand. The C horizon has value of 5 or 6 and chroma of 2 through 4. It generally is fine sand, but sand is within the range.

Lino Variant

The Lino Variant consists of moderately well drained, rapidly permeable soils on outwash plains and lake plains. They formed in fine sand outwash material. Slope ranges from 2 to 6 percent.

The Lino Variant soils formed in materials similar to the Anoka, Gotham, Isanti, Lino, Soderville, and Zimmerman soils and are commonly adjacent to these soils. The Anoka, Gotham, and Zimmerman soils are well drained to excessively drained and occupy slightly higher positions on the landscape. The somewhat poorly drained Lino and Soderville soils and the very poorly drained Isanti soils occupy lower areas where there is a high water table.

Typical pedon of Lino Variant loamy fine sand, 2 to 6 percent slopes, 350 feet east and 600 feet south of northwest corner of section 16, T. 31 N., R. 21 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loamy fine sand, brown (10YR 5/3) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.
B21—7 to 14 inches; dark yellowish brown (10YR 4/4) fine sand, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.
B22—14 to 28 inches; yellowish brown (10YR 5/4) fine sand, pale brown (10YR 6/3) dry; single grain; loose; neutral; clear smooth boundary.
A'2—28 to 38 inches; pale brown (10YR 6/3) fine sand, very pale brown (10YR 7/3) dry; few medium faint yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6 and 10YR 6/8) mottles; single grain; loose; neutral; clear smooth boundary.
B'21—38 to 54 inches; yellowish brown (10YR 5/4) fine sand; common fine and medium faint yellowish brown (10YR 5/6) mottles; single grain; loose; neutral; clear smooth boundary.
B'22t—54 to 60 inches; dark yellowish brown (10YR 4/4) fine sand; many fine and medium distinct yellowish

brown (10YR 5/6) and brownish yellow (10YR 6/6 and 10YR 6/8) mottles; single grain; loose; few thin (3 to 15mm thick) dark brown (7.5YR 4/4) loamy fine sand bands; neutral.

Solum thickness ranges from 30 to 60 inches. The solum ranges from slightly acid to neutral.

The Ap horizon has value of 3 or 4 and chroma of 1 or 2. In undisturbed pedons values of 2 or 3 are common. The A horizon typically is loamy fine sand or fine sand, but sand and loamy sand are within the range. The A'2 horizon has value of 4 through 7, has chroma of 2 or 3, and is fine sand or sand. The B2 and B'2 horizons have value of 4 through 6 and chroma of 3 or 4 and are fine sand or sand. The lower part of the B'2 horizon of most pedons has thin loamy fine sand or heavy fine sand lamallae 3 to 15 mm thick. Some pedons have a C horizon.

Mahtomedi series

The Mahtomedi series consists of excessively drained, rapidly permeable soils on glacial ground moraine. They formed in noncalcareous sand and gravelly sand outwash. Slope ranges from 0 to 40 percent.

Mahtomedi soils are similar to Antigo, Chetek, and Rosholt soils and are commonly adjacent to Brill, Antigo, Chetek, and Rosholt soils. Antigo soils have a 20- to 40-inch silt cap over stratified sand and gravel. Brill soils are moderately well drained silt capped sands that are below the Mahtomedi soils on the landscape. Chetek soils have 12 to 20 inches of loam over stratified sand and gravel. Rosholt soils have 20 to 40 inches of loam over stratified sand and gravel.

Typical pedon of Mahtomedi loamy sand, 12 to 25 percent slopes, 2,240 feet south and 100 feet east of the northwest corner of section 16, T. 30 N., R. 21 W.

A1—0 to 5 inches; very dark gray (10YR 3/1) loamy sand; very dark grayish brown (10YR 3/2) dry; weak medium and fine granular structure; very friable; about 10 percent coarse fragments; medium acid; abrupt smooth boundary.

A2—5 to 8 inches; brown (7.5YR 5/2) sand, yellowish brown (10YR 5/4) dry; single grain; loose; about 10 percent coarse fragments; strongly acid; clear smooth boundary.

B21—8 to 15 inches; dark brown (7.5YR 4/4) gravelly coarse sand; single grain; loose; about 35 percent coarse fragments with 10 percent more than 3 inches in diameter; strongly acid; clear smooth boundary.

B22—15 to 30 inches; reddish brown (5YR 4/4) gravelly coarse sand; single grain; loose; about 20 percent coarse fragments with 2 percent more than 3 inches in diameter; strongly acid; gradual smooth boundary.

C1—30 to 44 inches; reddish brown (5YR 5/4) gravelly sand; single grain; loose; about 27 percent coarse fragments with 1 percent more than 3 inches in diameter; strongly acid; gradual smooth boundary.

C2—44 to 60 inches; light reddish brown (5YR 6/3) gravelly sand; single grain; loose; about 15 percent coarse fragments with 1 percent more than 3 inches in diameter; medium acid.

The solum thickness typically is 20 to 40 inches. Coarse fragments typically range from 10 to 20 percent by volume in the solum.

The A1 horizon has value of 2 or 3 and chroma of 1 or 2. In cultivated areas the Ap horizon has value of 3 or 4 and chroma of 1 through 3. The A2 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 1 or 2. The A horizon typically is coarse sand, sand, loamy coarse sand, or loamy sand; however, fine sand, loamy fine sand, coarse sandy loam, sandy loam, and fine sandy loam are in the range. The A horizon is slightly acid to strongly acid. The B horizon has hue of 5YR, 7.5YR, or 10YR; value of 4 or 5; and chroma of 4 through 6. It typically is medium or coarse sand, but in some pedons it is fine sand. Reaction of this B horizon is slightly acid to strongly acid. A thin B1 or B3 horizon is in some pedons. The C horizon has hue of 5YR, 7.5YR, or 10YR; value of 5 or 6; and chroma of 3 or 4. It has texture similar to the B horizon and is strongly acid through slightly acid.

Mahtomedi Variant

The Mahtomedi Variant consists of excessively drained, rapidly permeable soils on bedrock controlled uplands. They formed in a dominantly sandy mantle of erosional sediments and residuum weathered from sandstone bedrock. Slope ranges from 24 to 60 percent.

Mahtomedi Variant soils are similar to the Mahtomedi soils and are commonly adjacent to the Antigo, Chetek, Copaston, Emmert, Mahtomedi, Rosholt, and Santiago soils. The Antigo, Chetek, and Rosholt soils formed in loamy material underlain by stratified sand and gravel. The Copaston soils have a lithic contact beginning at a depth of 12 to 20 inches. The Emmert and Mahtomedi soils formed entirely in sandy and gravelly glacial outwash. The Santiago soils formed in silty mantled glacial till.

Typical pedon of Mahtomedi Variant sandy loam from an area of Mahtomedi Variant-Rock outcrop complex, 25 to 60 percent slopes, 1,915 feet west and 890 feet north of the southeast corner of section 30, T. 32 N., R. 19 W.

A1—0 to 3 inches; very dark gray (10YR 3/1) sandy loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; friable; medium acid; abrupt smooth boundary.

B21—3 to 11 inches; reddish brown (5YR 4/4) loamy sand, dark brown (7.5YR 4/4) dry; weak very fine subangular blocky structure; friable; strongly acid; clear smooth boundary.

B22—11 to 20 inches; dark brown (7.5YR 4/4) loamy sand; single grain; loose; strongly acid; clear smooth boundary.
B23—20 to 32 inches; brown (7.5YR 5/4) loamy sand; single grain; loose; strongly acid; clear smooth boundary.
IIB3—32 to 42 inches; yellowish brown (10YR 5/4) sand; single grain; loose; medium acid; clear smooth boundary.
Cr—42 to 60 inches; light brownish gray (10YR 6/2) weakly indurated sandstone; single grain; loose; strongly acid.

The thickness of the solum is 24 to 45 inches. Coarse fragments range from 10 to 30 percent of the IIC horizon. Depth to the underlying sandstone or limestone ranges from 40 to 80 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam or fine sandy loam and is strongly acid through slightly acid. The B2 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 through 5. It is loamy sand or loamy fine sand and is strongly acid to medium acid. The IIB3 horizon has hue of 10YR or 7.5YR, value of 4 through 6, chroma of 3 through 6, and is fine sand or sand.

Markey series

The Markey series consists of very poorly drained, moderately rapidly permeable soils. These soils formed in 15 to 50 inches of organic material over sandy materials. They are in bogs and other depressional areas on outwash plains, lake plains, and moraines.

Markey soils are similar to Cathro, Rifle, and Seelyeville soils and are commonly adjacent to Blomford, Isanti, Kratka, Lino, and Soderville soils on the landscape. Cathro soils have 15 to 50 inches of sapric material over loam. Seelyeville soils have more than 50 inches of sapric material. Rifle soils consist of hemic organic materials. The Blomford, Isanti, Kratka, Lino, and Soderville soils are very poorly drained to somewhat poorly drained sandy soils near the edge of the bogs.

Typical pedon of Markey muck, 770 feet south and 165 feet east of the northwest corner of section 8, T. 32 N., R. 21 W.

Oa1—0 to 9 inches; black (10YR 2/1) on broken face and rubbed sapric material; about 12 percent undisturbed and 3 percent rubbed fiber content; about 20 percent mineral content; moderate medium and coarse granular structure; friable; abundant roots; slightly acid; clear smooth boundary.
Oa2—9 to 30 inches; sapric material that is 60 percent black (10YR 2/1) and 40 percent brown (7.5YR 4/2) on broken face and very dark brown (10YR 2/2) rubbed; 20 percent undisturbed and 6 percent rubbed fiber content; 35 percent mineral content; massive parting to weak thick platy structure; friable; few roots; slightly acid; abrupt smooth boundary.
IIA1b—30 to 36 inches; black (10YR 2/1) mucky loamy fine sand; few fine distinct olive brown (2.5Y 4/4) mottles; single grain; friable; neutral; clear smooth boundary.
IICg—36 to 60 inches; olive gray (5Y 5/2) stratified sand, fine sand, and loamy very fine sand; few fine faint olive (5Y 5/6) mottles; single grain; friable; mildly alkaline.

The depth to the sandy IIAb or IICg horizon commonly is 24 to 42 inches and ranges from 15 to 50 inches. The organic soil layers have hue of 10YR or 7.5YR, value of 2 through 4, and chroma of 1 or 2. Rubbed soil colors may vary from broken face color by 1 to 2 units in chroma and value. The surface tier is typically sapric material but some pedons contain hemic material. The organic layers within the subsurface tier dominantly are sapric material but some pedons have thin hemic layers 5 inches or less in thickness. Commonly the organic layers just above the IIAb or IICg horizon contain more mineral soil material than the overlying organic layers. The IIAb horizon is fine sand in some pedons. The IICg horizon has hue of 10YR through 5Y, value of 5 or 6, and chroma of 0 to 2. It is sand or fine sand, but strata of loamy very fine sand are in some pedons.

Nessel series

The Nessel series consists of moderately well drained, moderately permeable soils on ground and end moraines. They formed in loamy calcareous glacial till. Slope ranges from 1 to 4 percent.

Nessel soils are similar to Freeon soils and are adjacent to Bluffton, Dundas, and Hayden soils. Bluffton soils are very poorly drained, and Dundas soils are poorly drained. They are in depressions and drainageways. Freeon soils formed in reddish noncalcareous loamy till. Hayden soils are well drained and are steeper and higher on the landscape.

Typical pedon of Nessel fine sandy loam, 1 to 4 percent slopes, 790 feet west and 1,060 feet north of the southeast corner of section 17, T. 32 N., R. 21 W.

A1—0 to 4 inches; very dark gray (10YR 3/1) fine sandy loam, gray (10YR 5/1) dry; weak medium granular structure; very friable; plentiful roots; about 1 percent coarse fragments; slightly acid; abrupt smooth boundary.
A2—4 to 13 inches; dark grayish brown (10YR 4/2) fine sandy loam, light gray (10YR 7/2) dry; weak medium platy structure; very friable; plentiful roots; about 1 percent coarse fragments; many dark worm casts in fine pores; medium acid; clear smooth boundary.
B&A—13 to 17 inches; yellowish brown (10YR 5/4) fine sandy loam, grayish brown (10YR 5/2) on exterior; weak medium subangular blocky structure; friable; thick grayish brown (10YR 5/2) clay films on vertical faces of peds and patches on horizontal faces; strongly acid; clear smooth boundary.

B21t—17 to 27 inches; brown (10YR 5/3) fine sandy loam; few medium faint yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; few roots; about 2 percent coarse fragments; light brownish gray (10YR 6/2) coatings of clean sand and silt particles on vertical ped faces; few patchy clay films on faces of peds and in fine pores; strongly acid; clear smooth boundary.

B22t—27 to 41 inches; brown (10YR 5/3) loam; common medium faint yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; few roots; about 2 percent coarse fragments; light brownish gray (10YR 6/2) and yellowish brown (10YR 5/6) grainy coats on faces of peds, common dark grayish brown (10YR 4/2) and very dark gray (10YR 3/1) clay films on faces of peds; strongly acid; abrupt wavy boundary.

C1—41 to 45 inches; light olive brown (2.5Y 5/4) fine sandy loam; many medium distinct yellowish brown (10YR 5/6), brownish yellow (10YR 6/6), and grayish brown (10YR 5/2) mottles; massive; friable; few roots; about 4 percent coarse fragments; very dark gray (10YR 3/1) clay films in root channels; mildly alkaline; slight effervescence; clear wavy boundary.

C2—45 to 60 inches; light olive brown (2.5Y 5/4) fine sandy loam; common medium distinct yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) mottles; massive; friable; few roots; about 5 percent coarse fragments; lime threads; splotches of soft iron manganese concretions; moderately alkaline; strong effervescence.

The thickness of the solum and depth to free carbonates range from 32 to 46 inches. The solum is strongly acid to neutral, and the C horizon is mildly alkaline or moderately alkaline.

The Ap and A1 horizons have value of 2 or 3 and chroma of 1 or 2. The A2 horizon has value of 4 and 5 and chroma of 1 and 2. The texture of the A horizon is fine sandy loam or loam. In the B&A horizon, color and texture are intermediate to those of the A2 horizon above and of the B horizon below. The B2t horizon has hue of 10YR through 2.5Y, value of 3 through 5, and chroma of 3 and 4. Mottles or patchy to nearly continuous coatings on ped faces have chroma of 2 or less. The texture of the B horizon is fine sandy loam, loam, or sandy clay loam. The C horizon has value of 4 or 5 and chroma of 3 through 6. The texture is fine sandy loam or loam.

Ostrander series

The Ostrander series consists of well drained soils on loess covered uplands. They formed in 24 to 40 inches of loess and the underlying loamy glacial till. Permeability is moderate. Slope ranges from 0 to 12 percent.

Ostrander soils, as mapped in Washington County, typically have thicker mantles of loess and have a thinner solum than is defined as the range for the Ostrander series. These differences do not alter the usefulness or behavior of these soils.

Ostrander soils are similar to the Baytown, Richwood, Santiago, and Waukegan soils and are commonly adjacent to the Baytown, Lindstrom, and Waukegan soils. Baytown soils have sandstone bedrock directly below the solum. Lindstrom soils are well drained and formed in deep silty colluvium. Santiago soils formed in loess mantled glacial till of a younger age. Richwood and Waukegan soils formed in loess mantled outwash.

Typical pedon of Ostrander silt loam, 2 to 6 percent slopes, 1,320 feet south and 800 feet west of the northeast corner of section 31, T. 27 N., R. 20 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to weak fine granular; friable; slightly acid; abrupt smooth boundary.

A3—10 to 14 inches; very dark grayish brown (10YR 3/2) silt loam; strong medium subangular blocky structure; friable; slightly acid; clear wavy boundary.

B21—14 to 18 inches; dark brown (10YR 3/3) silt loam; strong medium subangular blocky structure; friable; few thin discontinuous clay films on ped faces; medium acid; clear wavy boundary.

B22—18 to 30 inches; brown (10YR 4/3) silt loam; strong medium subangular blocky structure; friable; medium acid; clear wavy boundary.

IIB3—30 to 36 inches; dark yellowish brown (10YR 4/4) loam; strong medium subangular blocky structure; firm; few thin discontinuous clay films on ped faces; about 10 percent coarse fragments; neutral; clear wavy boundary.

IIC—36 to 60 inches; yellowish brown (10YR 5/4) clay loam; few fine distinct strong brown (7.5YR 5/8) mottles; massive; firm; mildly alkaline.

The thickness of the solum and depth to free carbonates range from 30 to 76 inches. Depth to the underlying glacial till ranges from 30 to 56 inches.

The A horizon has value of 2 or 3 and chroma of 1 through 3. The B horizon has value and chroma of 3 or 4. The A and B horizons are loam or silt loam. They are neutral to medium acid. Faint to distinct mottles are in the lower B horizon in some pedons. The IIB horizon has value of 4 or 5 and chroma of 4 through 8. It is loam, sandy clay loam, or sandy loam and has one or more stone lines which are up to 30 percent coarse fragments. The IIC horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 4 through 8. It is clay loam, loam, sandy clay loam, or sandy loam and is neutral to mildly alkaline.

Otter series

The Otter series consists of poorly drained, moderately permeable soils in lower parts of upland drainageways. Slope ranges from 0 to 2 percent.

The Otter series, as mapped in Washington and Ramsey Counties, is outside the range of the series in that the mollic colors extend to too great a depth. This difference, however, does not alter the usefulness or behavior of the soils.

Otter soils are similar to Lindstrom soils and are commonly adjacent to them. The well drained Lindstrom soils have 3-chroma colors at a depth of about 30 inches.

Typical pedon of Otter silt loam, 1,325 feet east and 50 feet north of the southwest corner of section 10, T. 27 N., R. 20 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

A12—9 to 16 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate coarse subangular blocky structure; friable; neutral; abrupt wavy boundary.

A13—16 to 38 inches; black (N 2/0) silt loam; moderate fine granular structure; friable; slightly acid; clear smooth boundary.

AC—38 to 60 inches; black (10YR 2/1) silt loam; common fine distinct yellowish brown (10YR 5/6) mottles; massive; firm; neutral.

The thickness of the A horizon is commonly less than 40 inches. The A and AC horizons are black (N 2/0) to very dark gray (10YR 3/1). They are silt loam, mucky silt, or loam and range from slightly acid to mildly alkaline. Some pedons have a lighter colored C horizon which is mottled. Some contain strata of silt loam, loam, sandy loam, or silty clay loam.

Poskin series

The Poskin series consists of somewhat poorly drained soils that formed in a moderately deep mantle of dominantly silty deposits over outwash. Permeability is moderate in the silty mantle and very rapid in the underlying material. These soils occupy plane and slightly concave positions in drainageways and depressions. Slope ranges from 1 to 3 percent.

These soils, as mapped in Washington and Ramsey Counties, have a thicker and darker colored surface layer than is defined as the range for the Poskin series. They also lack an argillic horizon. These differences, however, do not alter their usefulness or behavior.

Poskin soils are similar to the Brill and Comstock soils and are commonly adjacent to the Antigo, Barronett, sandy substratum, and Brill soils. Comstock soils lack sand and gravel within 40 inches of the surface. The well drained Antigo soils and moderately well drained Brill soils occupy higher positions on the landscape than Poskin soils and lack mottles with chroma of 2 or less in the upper 10 inches of the argillic horizon. The Barronett sandy substratum soils are poorly drained and occupy lower positions on the landscape.

Typical pedon of Poskin silt loam, 1,200 feet south and 50 feet east of the northwest corner of section 23, T. 28 N., R. 21 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A12—9 to 13 inches; black (10YR 2/1) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

B1—13 to 20 inches; dark grayish brown (2.5Y 4/2) silt loam; common fine prominent yellowish red (5YR 4/8) mottles; moderate medium subangular blocky structure; friable; medium acid; gradual wavy boundary.

B2—20 to 28 inches; dark brown (10YR 4/3) silt loam; common medium faint grayish brown (10YR 5/2) and common medium distinct yellowish red (5YR 4/8) mottles; moderate fine subangular blocky structure; friable; medium acid; gradual wavy boundary.

B3—28 to 33 inches; yellowish brown (10YR 5/4) loam; common fine distinct yellowish red (5YR 4/8) and common medium faint grayish brown (10YR 5/2) mottles; weak fine and moderate subangular blocky structure; very friable; about 1 percent coarse fragments; slightly acid; clear wavy boundary.

IIC1—33 to 58 inches; dark yellowish brown (10YR 4/4) medium and coarse sand; single grain; loose; about 10 percent coarse fragments; slightly acid; clear wavy boundary.

IIC2—58 to 60 inches; strong brown (7.5YR 5/6) gravelly medium and coarse sand; single grain; loose; about 20 percent coarse fragments; neutral.

The silty mantle and the solum typically range from 20 to 36 inches in thickness. In some pedons the solum extends into the underlying sand and gravel. The solum is slightly acid or medium acid, and the underlying material is slightly acid or neutral.

The Ap and A1 horizons have value of 2 or 3 and chroma of 1 or 2. The B2 horizon has hue of 2.5Y, 10YR, or 7.5YR; value of 4 or 5; and chroma of 2 through 4. The IIC horizon is fine, medium, or coarse sand and gravel. It has hue of 10YR, 7.5YR, and 5YR and value and chroma of 4 through 6. Gravel content ranges from 10 to about 40 percent.

Prebish series

The Prebish series consists of very poorly drained, moderately slowly permeable soils on ground moraines.

They formed in loamy glacial till. Slope ranges from 0 to 2 percent.

Prebish soils are similar to Bluffton and Kratka soils and commonly are adjacent to Freeon, Kingsley, and Ronneby soils. Bluffton soils formed in grayish loamy glacial till. Kratka soils are poorly drained and formed in sand mantled glacial till. Freeon soils are moderately well drained, and Kingsley soils are well drained. They are steeper and higher on the landscape than Prebish soils. Ronneby soils are somewhat poorly drained and are in slightly higher positions.

Typical pedon of Prebish loam, 1,770 feet east and 1,980 feet south of the northwest corner of section 9, T. 29 N., R. 20 W.

A1—0 to 17 inches; black (10YR 2/1) loam; weak thick platy structure; friable; dark brown (7.5YR 3/2) fillings in root channels; friable; medium acid; abrupt wavy boundary.

B1g—17 to 23 inches; gray (10YR 5/1) loam; many fine faint strong brown (7.5YR 5/6) mottles; weak thick platy structure; friable; medium acid; abrupt wavy boundary.

B21g—23 to 27 inches; olive gray (5Y 5/2) loam; many medium distinct strong brown (7.5YR 5/6) mottles; weak thick platy structure parting to weak fine subangular blocky; friable; medium acid; clear wavy boundary.

B22g—27 to 32 inches; dark reddish gray (5YR 4/2) sandy loam; common medium distinct reddish brown (5YR 4/4) and dark gray (5YR 4/1) mottles; moderate medium subangular blocky structure; friable; medium acid; clear wavy boundary.

B3—32 to 48 inches; variegated strong brown (7.5YR 5/6), reddish brown (5YR 4/3), and dark gray (10YR 4/1) sandy loam; weak medium and thick platy structure; friable; medium acid; clear wavy boundary.

IIC—48 to 60 inches; reddish brown (5YR 4/3) sandy loam; common medium faint yellowish red (5YR 4/6) mottles; weak thick platy structure; firm; slightly acid.

The thickness of the solum and depth to the firm or very firm IIC horizon range from 40 to 60 inches. The solum ranges from medium acid to neutral. Some pedons have an O horizon up to 8 inches thick.

The A horizon generally has value of 2 or 3 and chroma of 1, or it is N 2/0. Faint to prominent mottles are in the lower part in some pedons. The A horizon is loam, sandy loam, or fine sandy loam, but silt loam is within the range. The upper part of the Bg horizon has hue of 10YR, value of 4 or 5, and chroma of 1; or it has hue of 2.5Y and chroma of 2 or less. The lower part of the Bg horizon has hue of 5YR or 10YR, value of 4 or 5, and chroma of 2 or less in the matrix or mottles. It typically is fine sandy loam, sandy loam, or loam. The B3 and IIC horizons have hue of 5YR or 7.5YR, value of 3 through 5, and chroma of 3 through 6. They are sandy loam or coarse sandy loam. The IIC horizon ranges from medium acid to mildly alkaline.

Richwood series

The Richwood series consists of well drained soils on outwash plains and stream terraces. They formed in 40 to 60 inches of moderately permeable silty sediments over rapidly permeable, weakly stratified fine and medium sands. Slope ranges from 0 to 6 percent.

Richwood soils are similar to the Antigo, Baytown, Gale, and Waukegan soils and are commonly adjacent to the Waukegan soils. Antigo soils formed in a thinner silty mantle over reddish sand and gravel and lack a mollic epipedon. Baytown and Gale soils are underlain by sandstone bedrock within a depth of 40 inches. Waukegan soils are slightly more sloping than Richwood soils and are shallower to the underlying sands.

Typical pedon of Richwood silt loam, 0 to 2 percent slopes, 2,310 feet west and 2,375 feet north of the southeast corner of section 16, T. 29 N., R. 23 W.

Ap—0 to 11 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; moderate medium and coarse granular structure; friable; neutral; abrupt smooth boundary.

A12—11 to 19 inches; very dark grayish brown (10YR 3/2) silt loam; moderate medium and coarse granular structure; friable; slightly acid; abrupt wavy boundary.

B1—19 to 24 inches; dark brown (10YR 4/3) silt loam; moderate fine subangular blocky structure; friable; slightly acid; clear wavy boundary.

B21t—24 to 32 inches; dark yellowish brown (10YR 4/4) silty clay loam; strong medium subangular blocky structure; firm; few thin clay films on ped faces and in pores; medium acid; clear wavy boundary.

B22t—32 to 39 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; few thin clay films on ped faces and in pores; firm; medium acid; clear wavy boundary.

B3t—39 to 49 inches; brown (10YR 4/3) silt loam; weak medium subangular blocky structure; friable; slightly acid; smooth boundary.

IIC—49 to 60 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) sand; single grain; loose; about 5 percent coarse fragments; slightly acid.

The solum ranges from 40 to 65 inches thick, and the depth to the IIC horizon is 40 to 60 inches. The solum is neutral to medium acid, and the IIC horizon is slightly acid or neutral.

The A1 or Ap horizon has value of 2 or 3 and chroma of 1 or 2. The A12 horizon has value of 3, chroma of 2 or 3. The B1 horizon has value and chroma of 3 or 4. It is silty clay loam in some pedons. The Bt horizon has hue of 10YR or 7.5YR and value and chroma of 3 through 5. It is silt loam or silty clay loam. Clay films are few to many and thin to moderately thick on faces of peds. Some pedons have a IIB3 horizon. The IIC horizon

has hue of 10YR or 7.5YR, value of 4 through 8, and chroma of 2 through 6. It is fine or medium sand.

Rifle series

The Rifle series consists of very poorly drained, moderately rapidly permeable soils in bogs and depressional areas. They formed in partly decomposed herbaceous organic material.

Rifle soils are similar to Cathro, Markey, and Seelyeville soils. Cathro and Markey soils have loamy or sandy material at a depth of less than 51 inches. Seelyeville soils consist of more than 50 inches of dominantly sapric material.

Typical pedon of Rifle muck, 495 feet north and 45 feet east of the southwest corner of section 21, T. 31 N., R. 21 W.

Oa1—0 to 9 inches; black sapric material; black (N/2) on broken face and (10YR 2/1) rubbed; about 10 percent fiber, about 3 percent rubbed; weak medium granular structure; friable; abundant roots; neutral; abrupt smooth boundary.

Oe1—9 to 16 inches; hemic material, brown (7.5YR 4/4) on broken face and dark brown (10YR 3/3) rubbed; about 55 percent fiber, about 20 percent rubbed; about 17 percent mineral content; strong medium and thick platy structure parting to moderate thin platy; friable; few roots; neutral; abrupt smooth boundary.

Oe2—16 to 21 inches; hemic material, brown (7.5YR 5/4) on broken face and very dark grayish brown (10YR 3/2) rubbed; about 60 percent fiber, about 25 percent rubbed; about 8 percent mineral content; strong medium and thick platy structure; friable; few roots; slightly acid; clear smooth boundary.

Oe3—21 to 50 inches; hemic material, dark yellowish brown (10YR 4/4) on broken face and brown (10YR 4/3) rubbed; about 55 percent fiber, about 25 percent rubbed; about 3 percent mineral content; massive; friable; slightly acid; clear smooth boundary.

Oe4—50 to 60 inches; hemic material, dark brown (10YR 3/3) on broken face and very dark grayish brown (10YR 3/2) rubbed; about 40 percent fiber, about 20 percent rubbed; about 6 percent mineral content; massive; friable; slightly acid; clear smooth boundary.

The thickness of the organic soil layers exceeds 51 inches. Limnic sediments or mineral materials are commonly above a depth of 60 inches. Some pedons contain woody fragments in the surface tier. Mineral material ranges from about 5 to 20 percent in the control section.

The surface tier has hue of 10YR or 7.5YR, value of 2 through 4, and chroma of 1 through 4 or is N 2/0. In some pedons the surface 7 to 12 inches is highly decomposed sapric material. The layers in the subsurface and bottom tiers have hue of 10YR or 7.5YR and value and chroma of 2 through 5. These layers are dominantly hemic material and typically are 10 to 25 percent rubbed fiber. In some pedons thin layers of sapric or fibric materials are within the subsurface and bottom tiers, but the total thickness of either material is less than 10 inches.

Ripon series

The Ripon series consists of well drained soils on loess covered uplands. They formed in moderately permeable silty sediments over limestone bedrock. Slope ranges from 1 to 12 percent.

Ripon soils are similar to the Baytown, Gale, and Richwood soils and are commonly adjacent to the Whalan soils. Baytown and Gale soils are underlain by sandstone bedrock. Richwood soils lack a lithic or paralithic contact within a depth of 40 inches. Whalan soils are fine-loamy.

Typical pedon of Ripon silt loam, 6 to 12 percent slopes, 1,900 feet east and 200 feet south of the northwest corner of section 33, T. 27 N., R. 20 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A13—8 to 11 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) silt loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; slightly acid; abrupt wavy boundary.

B1—11 to 16 inches; dark brown (10YR 3/3) silt loam; weak fine and medium subangular blocky structure; friable; medium acid; gradual smooth boundary.

B2—16 to 24 inches; brown (10YR 4/3) silt loam; weak fine and medium subangular blocky structure; friable; slightly acid; abrupt irregular boundary.

R—24 inches; light yellowish brown (10YR 6/4) and light yellowish brown (2.5YR 6/4) level bedded limestone bedrock.

Thickness of the solum ranges from 20 to 40 inches, which corresponds to the thickness of the soil above the lithic contact. A IIB horizon formed in glacial till in some pedons.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has value of 3 through 5 and chroma of 3 or 4, and it is clay loam in some pedons. The B horizon is up to 15 percent by volume coarse limestone fragments.

Ronneby series

The Ronneby series consists of somewhat poorly drained soils that formed in loamy glacial till on ground moraine. Permeability is moderately rapid in the surface layer and subsoil and moderately slow in the underlying material. Slope ranges from 0 to 2 percent.

Ronneby soils, as mapped in Washington and Ramsey Counties, are outside the range defined for the series in

that they lack a fragipan. This difference, however, does not alter their usefulness or behavior.

Ronneby soils are similar to Freer soils and are commonly adjacent to Kingsley, Freeon, and Prebish soils. Freer soils occupy similar positions on the landscape, but formed in silt-mantled glacial till. Kingsley soils are well drained, and Freeon soils are moderately well drained. They are at a slightly higher elevation than Ronneby soils. Prebish soils are very poorly drained and are in shallow depressions.

Typical pedon of Ronneby fine sandy loam, 1,640 feet north and 490 feet west of the southeast corner of section 1, T. 31 N., R. 21 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) fine sandy loam; grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; about 2 percent coarse fragments; strongly acid; abrupt smooth boundary.

A21—9 to 14 inches; light brownish gray (10YR 6/2) fine sandy loam, white (10YR 8/2) dry; many large distinct yellowish red (5YR 5/8) and strong brown (7.5YR 5/8) mottles; weak medium platy structure; very friable; about 3 percent coarse fragments; medium acid; clear smooth boundary.

A22—14 to 18 inches; light brownish gray (10YR 6/2) fine sandy loam, light gray (10YR 7/1) dry; common large distinct dark brown (7.5YR 4/4) and strong brown (7.5YR 5/8) mottles; weak medium platy structure; friable; about 3 percent coarse fragments; medium acid; clear smooth boundary.

B21tg—18 to 28 inches; dark grayish brown (10YR 4/2) loam; many medium distinct yellowish red (5YR 4/8) mottles; moderate coarse prismatic structure parting to moderate medium subangular blocky; friable; many thick very dark grayish brown (10YR 3/2) clay films on ped faces and in pores; about 10 percent coarse fragments; medium acid; clear smooth boundary.

B22t—28 to 41 inches; reddish brown (5YR 4/4) sandy loam; many medium faint reddish gray (5YR 5/2) and yellowish red (5YR 4/6) mottles; weak medium platy structure parting to moderate medium subangular blocky; friable; few thin clay films on vertical ped faces; about 8 percent coarse fragments; medium acid; clear smooth boundary.

C1—41 to 50 inches; reddish brown (5YR 4/4) sandy loam; common medium faint dark reddish brown (5YR 3/4) and yellowish red (5YR 5/8) mottles; weak very thick platy structure; firm; about 10 percent coarse fragments; slightly acid; clear smooth boundary.

C2—50 to 60 inches; reddish brown (5YR 4/4) sandy loam; few medium faint dark reddish brown (5YR 3/4) and yellowish red (5YR 5/8) mottles; weak very thick platy structure; firm; about 10 percent coarse fragments; neutral.

Thickness of the solum ranges from 40 to 60 inches, and depth to free carbonates is 50 to more than 60 inches. The B and C horizons are 8 to 20 percent by volume coarse fragments, and the highest amount is generally in the upper part of the B horizon.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The A2 horizon has hue of 10YR or 7.5YR, value of 3 through 6, and chroma of 1 or 2. It has distinct or prominent mottles. The A horizon typically is loam or fine sandy loam, but silt loam, sandy loam, very fine sandy loam, or loamy sand are within the range. The A horizon is strongly acid to slightly acid. The B2 horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 or 5; and chroma of 2 through 4. It is sandy loam, fine sandy loam, or loam and ranges from strongly acid to slightly acid. The C horizon has hue of 2.5YR or 5YR and value and chroma of 3 or 4. It is sandy loam or fine sandy loam and ranges from slightly acid to mildly alkaline.

Rosholt series

The Rosholt series consists of well drained soils on outwash plains. They formed in a 20- to 40-inch loamy mantle and the underlying sand and gravelly sand. Permeability is moderately rapid in the solum and very rapid in the underlying material. Slope ranges from 1 to 15 percent.

Rosholt soils are similar to Antigo, Chetek, and Mahtomedi soils and are commonly adjacent to Kingsley, Demontreville, and Poskin soils. Antigo soils formed in a silty mantle and underlying sand and gravel. Chetek and Mahtomedi soils have a thinner loamy mantle than Rosholt soils. Kingsley soils formed entirely in sandy loam till. Poskin soils are somewhat poorly drained and occupy lower positions on the landscape. Demontreville soils have a sandy mantle over sandy loam till.

Typical pedon of Rosholt sandy loam, 1 to 6 percent slopes, 40 feet north and 1,680 feet west of the southeast corner of section 18, T. 32 N., R. 20 W.

Ap—0 to 11 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; weak medium granular structure; very friable; about 12 percent coarse fragments; medium acid; abrupt smooth boundary.

B1—11 to 14 inches; brown (7.5YR 4/4) sandy loam; weak fine subangular blocky structure; very friable; about 10 percent coarse fragments; strongly acid; abrupt smooth boundary.

B2t—14 to 21 inches; reddish brown (5YR 4/4) sandy loam; moderate medium subangular blocky structure; firm; few thin clay films on ped faces; about 12 percent coarse fragments; strongly acid; clear smooth boundary.

IIB3t—21 to 31 inches; reddish brown (5YR 4/4) gravelly loamy coarse sand; weak fine granular structure; very friable; few clay bridges between sand grains; about 25 percent coarse fragments; strongly acid; clear wavy boundary.

IIC—31 to 60 inches; yellowish red (5YR 4/6) gravelly sand; single grain; loose; about 25 percent coarse fragments; medium acid.

The solum ranges from 20 to 40 inches in thickness and extends into the underlying sand and gravel. Coarse fragments range from less than 20 percent by volume in the upper part to 10 to 35 percent in the lower part of the solum.

The Ap horizon has value of 3 or 4 and chroma of 2 or 3. Some pedons have a 3- to 4-inch A1 horizon that is lower in value and chroma. The surface horizon is sandy loam or loam. Some pedons have an A2 horizon and an A&B or B&A horizon. The B2t horizon has hue of 5YR or 7.5YR and value and chroma of 3 through 5. It is sandy loam or loam. The IIB3t horizon has hue of 5YR or 7.5YR, value of 3 through 5, and chroma of 3 through 6. It is gravelly loamy sand or gravelly sandy loam. The IIC horizon is stratified medium or coarse sand and gravel. It has hue of 10YR, 7.5YR, or 5YR and value and chroma of 4 through 6. It is slightly acid through strongly acid.

Santiago series

The Santiago series consists of well drained, moderately slowly permeable soils on loess mantled glacial uplands. They formed in 15 to 30 inches of loess and the underlying loamy glacial till. Slope ranges from 2 to 15 percent.

Santiago soils are similar to the Ostrander soils and are commonly adjacent to the Auburndale, Freeon, and Freer soils. The Auburndale soils are poorly drained and occupy depressions and drainageways. The Freeon and Freer soils are more poorly drained than the Santiago soils and occupy lower, less sloping areas. The Ostrander soils are well drained and formed in 24 to 40 inches of loess or loamy erosional sediments over older glacial till.

Typical pedon of Santiago silt loam, 2 to 6 percent slopes, 1,300 feet east and 1,240 feet south of the northwest corner of section 28, T. 29 N., R. 21 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak very fine and fine granular structure; very friable; plentiful very fine and fine roots; slightly acid; abrupt smooth boundary.

A2—7 to 10 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate thin platy structure; friable; plentiful very fine and fine roots; slightly acid; clear smooth boundary.

B21t—10 to 16 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; moderate fine and medium subangular blocky structure; friable; many thin coatings of clean sand and silt particles on faces of peds; few thin clay films mostly on horizontal faces of peds and in pores; few very fine and fine roots; slightly acid; clear smooth boundary.

B22t—16 to 25 inches; dark brown (7.5YR 4/4) silt loam; moderate medium subangular blocky structure; firm; few thin coatings of clean sand and silt particles on faces of peds; few thin clay films on faces of peds; very few fine roots; about 2 percent coarse fragments in lower part of horizon; medium acid; clear smooth boundary.

IIB23t—25 to 30 inches; reddish brown (5YR 4/4) sandy loam; moderate medium platy structure; firm; continuous thin and medium dark brown (7.5YR 3/2) clay films on faces of peds in upper part grading to few thin clay films in lower part; about 12 percent coarse fragments; few very fine roots; medium acid; gradual smooth boundary.

IIB3t—30 to 40 inches; dark reddish brown (5YR 3/4) sandy loam; weak thin platy structure; firm; few thin clay films on faces of peds; about 12 percent coarse fragments; medium acid; diffuse smooth boundary.

IIC—40 to 60 inches; dark reddish brown (5YR 3/4) sandy loam; massive; firm; about 5 percent yellowish brown (10YR 5/4) silt loam and loam irregular and lenticular masses; about 12 percent coarse fragments; slightly acid.

The solum ranges from 20 to 40 inches in thickness and extends into the underlying glacial till. Coarse fragments are 8 to 20 percent by volume of the IIB and IIC horizons.

The A1 or Ap horizon has value of 2 through 4 and chroma of 1 through 3. The lower value colors are in the A1 horizon. The A2 horizon has value of 4 through 6 and chroma of 2 or 3. The A horizon is silt loam or silt and is slightly acid or neutral. Some pedons have an A&B or a B&A horizon. The B2t horizon has hue of 10YR or 7.5YR and value and chroma of 4 or 5. It is silt loam or heavy silt loam. The IIB2t horizon has hue of 7.5YR or 5YR and value and chroma of 3 or 4. It is loam, fine sandy loam, or sandy loam. The B and IIB horizons are slightly acid to strongly acid. The IIB3 and IIC horizons have hue of 5YR or 2.5YR and value and chroma of 3 through 5. Texture of the IIB3 and IIC horizons is sandy loam or fine sandy loam.

Seelyeville series

The Seelyeville series consists of very poorly drained, moderately rapidly permeable soils in depressions on outwash plains, in valley trains, and on glacial moraines. They formed in highly decomposed organic materials.

Seelyeville soils are similar to Cathro, Markey, and Rifle soils. Cathro soils are underlain by loamy sediment and Markey soils by sandy sediment within 51 inches of the surface. Rifle soils are composed of hemic material.

Typical pedon of Seelyeville muck, 1,950 feet west and 1,190 feet south of the northeast corner of section 8, T. 31 N., R. 21 W.

Oa1—0 to 7 inches; sapric material, black (N/2) on broken face and very dark brown (10YR 2/2)

rubbed; about 20 percent fiber, about 3 percent rubbed; about 20 percent mineral content; weak coarse granular structure; friable; plentiful roots; neutral; abrupt smooth boundary.

Oe1—7 to 11 inches; hemic material, dark brown (10YR 3/3) on broken face and very dark grayish brown (10YR 3/2) rubbed; about 55 percent fiber, about 35 percent rubbed; about 15 percent mineral content; moderate medium and fine platy structure; friable; few roots; neutral; clear smooth boundary.

Oa2—11 to 35 inches; black sapric material, (10YR 2/1) on broken face and (N/2) rubbed; about 20 percent fiber, about 7 percent rubbed; about 20 percent mineral content; weak thick and very thick platy structure; friable; neutral; clear smooth boundary.

Oe2—35 to 40 inches; hemic material, very dark grayish brown (10YR 3/2) on broken face, and very dark brown (10YR 2/2) rubbed; about 35 percent fiber, about 12 percent rubbed; about 10 percent mineral content; weak medium platy structure; friable; neutral; clear smooth boundary.

Oa3—40 to 54 inches; sapric material, very dark brown (10YR 2/2) on broken face and black (10YR 2/1) rubbed; about 20 percent fiber, about 5 percent rubbed; about 15 percent mineral content; weak thick platy structure; friable; neutral; clear smooth boundary.

Oa4—54 to 60 inches; sapric material, very dark brown (10YR 2/2) on broken face and black (10YR 2/1) rubbed; about 5 percent fiber, about 1 percent rubbed; about 25 percent mineral content; massive; friable; neutral.

Seelyeville soils typically have organic soil materials extending to a depth of more than 51 inches. A small amount of wood fibers and fragments are in the surface tier of some pedons. Mineral material commonly ranges from about 10 to 25 percent throughout the control section.

In some pedons hemic material comprises part to all of the surface tier. The subsurface and bottom tiers typically are sapric material, but some pedons have layers of hemic soil material as much as 10 inches thick. The sapric soil material has hue of 10YR or 7.5YR, value of 2, and chroma of 1 or it is N 2/0. Colors are for both the broken face and rubbed mass, but value of 3 and chroma of 2 are within the range for the broken face. The hemic soil material has hue of 10YR or 7.5YR and value and chroma of 2 or 3 on the broken face.

Soderville series

The Soderville series consists of somewhat poorly drained, rapidly permeable soils on outwash plains. They formed dominantly in deep fine sandy deposits that are of glacial outwash or eolian origin or both. Slope ranges from 0 to 3 percent.

Soderville soils are similar to Lino soils and are commonly adjacent to Anoka, Isanti, and Zimmerman soils. Anoka soils are well drained and occur in convex positions. Isanti soils are very poorly drained and occupy the deeper depressions and drainageways. Lino soils lack argillic horizons. Zimmerman soils are excessively drained and are on convex side slopes.

Typical pedon of Soderville loamy fine sand, 1,650 feet west and 1,815 feet south of northeast corner of section 31, T. 31 N., R. 21 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy fine sand, brown (10YR 5/3) dry; weak fine subangular blocky structure; very friable; plentiful roots; strongly acid; abrupt smooth boundary.

A2—8 to 17 inches; grayish brown (10YR 5/2) loamy fine sand, pale brown (10YR 6/3) dry; common medium faint dark yellowish brown (10YR 4/4) and light brownish gray (10YR 6/2) mottles; weak thin platy structure; very friable; few roots; medium acid; abrupt smooth boundary.

B21t—17 to 27 inches; dark brown (7.5YR 4/4) fine sandy loam; many coarse distinct strong brown (7.5YR 5/6) and light gray (10YR 7/2) mottles; weak medium subangular blocky structure; friable; few roots; about 4 percent coarse fragments; many thick clay films on ped faces and fractures; medium acid; abrupt smooth boundary.

A'2—27 to 38 inches; light gray (10YR 7/2) fine sand; many coarse distinct strong brown (7.5YR 5/6) and yellowish red (5YR 5/8) mottles; single grain; loose; few roots; medium acid; abrupt wavy boundary.

B'22t—38 to 47 inches; brown (10YR 5/3) loamy fine sand; many coarse distinct brown (7.5YR 5/4) and light gray (10YR 7/2) mottles; weak medium subangular blocky structure; very friable; about 1 percent coarse fragments; medium acid; abrupt wavy boundary.

C—47 to 60 inches; very pale brown (10YR 7/3) fine sand; common coarse distinct grayish brown (10YR 5/2) and brownish yellow (10YR 6/6) mottles; single grain; loose; medium acid.

Thickness of the solum commonly ranges from 36 to 60 inches or more. Reaction in the solum is strongly acid or medium acid.

The Ap and A1 horizons have value of 2 to 4 and chroma of 1 or 2 with the darker colors in the A1 horizon. The A2 horizon has value of 4 through 7 and chroma of 2 or 3. The A horizon typically is loamy fine sand or fine sand, but fine sandy loam is within the range. The B2t horizon has hue of 5YR, 7.5YR, or 10YR; value of 4 or 5; and chroma of 3 or 4. It is loamy fine sand, fine sandy loam, or sandy loam; and some pedons consist of multiple bands of these textures with intervening horizons of fine sand. There are commonly A'2 and B'2t horizons that have color and texture similar to the A2 and B2t horizons, respectively. The C horizon has matrix colors in hue of 10YR or 7.5YR, value of 4 through 7, and chroma of 3 through 5. It generally is fine sand but ranges to sand.

Sparta series

The Sparta series consists of excessively drained, rapidly permeable soils on outwash plains and stream terraces. They formed in sandy alluvium which is windreworked in many places. Slope ranges from 0 to 15 percent.

Sparta soils are similar to Hubbard, Mahtomedi, and Zimmerman soils and are commonly adjacent to Dickman and Hubbard soils. Dickman soils average less sand in the control section than Sparta soils. Hubbard soils have more coarse and very coarse sand throughout. Mahtomedi soils lack a mollic epipedon and are redder throughout. Zimmerman soils lack a mollic epipedon.

Typical pedon of Sparta loamy sand, 2 to 6 percent slopes, 2,610 feet east and 330 feet north of the southwest corner of section 29, T. 27 N., R. 21 W.

Ap—0 to 10 inches; black (10YR 2/1) loamy sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; very friable; medium acid; abrupt smooth boundary.

A3—10 to 16 inches; very dark grayish brown (10YR 3/2) loamy sand; weak coarse subangular blocky structure; very friable; medium acid; clear smooth boundary.

B2—16 to 28 inches; dark brown (10YR 4/3) loamy sand; weak coarse subangular blocky structure; very friable; medium acid; abrupt smooth boundary.

C—28 to 60 inches; brown (10YR 4/3) sand; single grain; loose; medium acid.

The thickness of the solum ranges from 24 to 40 inches, and the mollic epipedon is 10 to 24 inches thick. Except in the A horizon, which may be limed, these soils range from medium acid to strongly acid throughout.

The A1 horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. It is loamy sand, loamy fine sand, or sand. The A3 horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. It is sand, fine sand, loamy sand, or loamy fine sand. The B2 horizon has hue of 10YR or 7.5YR; value of 4, 5, or 6; and chroma of 3 through 6. It is sand, fine sand, loamy sand, or loamy fine sand. Fine sand and medium sand are dominant throughout the control section. The C horizon has hue of 10YR or 7.5YR; value of 4, 5, or 6; and chroma of 3 through 6. It is sand or fine sand.

Waukegan series

The Waukegan series consists of well drained soils on outwash plains, in valley trains, and on stream terraces. They formed in loess or silty alluvium and the underlying sandy material. Permeability is moderate in the silty mantle and rapid in the underlying sand and gravel. Slope ranges from 0 to 12 percent.

Waukegan soils are similar to Antigo, Dickman, and Richwood soils. Antigo soils have a lighter colored surface horizon and contain reddish brown sands. Dickman soils have sandy loam in the A horizon and upper part of the B horizon. Richwood soils formed in a silty mantle 40 to 60 inches thick over sand.

Typical pedon of Waukegan silt loam, 0 to 2 percent slopes, 1,440 feet east and 1,820 feet south of the northwest corner of section 1, T. 30 N., R. 19 W.

Ap—0 to 10 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; friable; few roots; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

B21—10 to 13 inches; dark yellowish brown (10YR 4/4) silt loam; weak fine and medium subangular blocky structure; friable; few roots; about 2 percent coarse fragments; strongly acid; clear smooth boundary.

B22—13 to 24 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; friable; about 4 percent coarse fragments; strongly acid; abrupt smooth boundary.

IIB3—24 to 31 inches; yellowish brown (10YR 5/4) coarse sand; single grain; loose; about 6 percent coarse fragments; medium acid; clear smooth boundary.

IIC—31 to 60 inches; light yellowish brown (10YR 6/4) coarse sand; single grain; loose; about 12 percent coarse fragments; slightly acid.

The solum thickness ranges from 30 to 60 inches, and the mollic epipedon is 9 to 12 inches thick. Depth to the IIB or IIC horizon is 20 to 40 inches. The solum is medium acid to neutral in the upper part and strongly acid to neutral in the lower part.

The A1 horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has value and chroma of 3 through 5. The A and B horizons are silt loam or light silty clay loam and, less commonly, are loam high in silt or very fine sand. The IIB3 horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 3 through 6. It is coarse sand, sand, loamy coarse sand, or loamy sand and is medium acid to neutral. The IIC horizon has value of 4 through 6 and chroma of 2 through 6. It is coarse sand or sand.

Waukegan Variant

The Waukegan Variant consists of well drained soils on uplands. They formed in a silty mantle of loess and the underlying sandy outwash. Permeability is moderate in the silty mantle and rapid in the underlying sandy part. Slope ranges from 0 to 9 percent.

The Waukegan Variant soils are similar to the Baytown, Copaston, and Waukegan soils and are commonly adjacent to the Waukegan soil. Baytown soils lack the contrasting outwash material of the Waukegan Variant and are underlain by sandstone bedrock. Copaston soils lack the contrasting outwash material and are coarse-

loamy. Waukegan soils lack a lithic contact within a depth of 40 inches.

Typical pedon of Waukegan Variant silt loam, 2 to 9 percent slopes, 1,900 feet east and 700 feet north of the southwest corner of section 5, T. 26 N., R. 20 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A3—8 to 12 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; moderate medium platy structure parting to moderate fine and medium subangular blocky; friable; slightly acid; clear wavy boundary.

B1—12 to 23 inches; dark brown (10YR 4/3) silt loam; moderate fine and medium subangular blocky structure; friable; medium acid; abrupt wavy boundary.

IIB2—23 to 35 inches; yellowish brown (10YR 5/4) fine sand; single grain; loose; medium acid; gradual wavy boundary.

IIB3—35 to 40 inches; brown (10YR 4/3) gravelly sand; single grain; loose; about 20 percent coarse fragments; neutral; abrupt irregular boundary.

R—40 inches; level bedded highly fractured limestone; dark colored residuum in fractures.

The solum is commonly 30 to 45 inches thick. The part of the solum that formed in silty sediments is commonly 12 to 24 inches thick.

The A horizon has value and chroma of 2 or 3. It typically is silt loam, but loam that is high in silt and very fine sand is within the range. It is medium acid to slightly acid. The B horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. The part of the B horizon that formed in the upper sediment typically is silt loam or loam. The part of the B horizon that formed in the lower sediment is fine sand, sand, or coarse sand. The B horizon is medium acid to neutral.

Webster series

The Webster series consists of poorly drained, moderately slowly permeable soils on till plains. They formed in loamy glacial till. Slope ranges from 0 to 2 percent.

Webster soils are similar to Bluffton and Kratka soils and are commonly adjacent to Dundas and Hayden soils. Bluffton soils are very poorly drained and are in depressions. Kratka soils formed in sand mantled glacial till. Dundas soils lack a mollic epipedon. They are slightly higher on the landscape than Webster soils. Hayden soils are well drained and are in the more sloping positions on the landscape.

Typical pedon of Webster loam, 2,460 feet east and 1,640 feet north of the southwest corner of section 7, T. 31 N., R. 21 W.

Ap—0 to 8 inches; black (N2.5/0) loam, black (10YR 2.5/1) dry; weak medium granular structure; friable; about 2 percent coarse fragments; plentiful roots; neutral; abrupt smooth boundary.

A12—8 to 13 inches; black (N2.5/0) clay loam, black (10YR 2.5/1) dry; weak fine subangular blocky and moderate coarse granular structure; friable; about 2 percent coarse fragments; few roots; neutral; clear smooth boundary.

A3—13 to 16 inches; very dark gray (10YR 3/1) clay loam; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; few roots; neutral; clear wavy boundary.

B2g—16 to 25 inches; olive gray (5Y 5/2) loam; few medium distinct brownish yellow (10YR 6/6) mottles; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; few roots; neutral; clear wavy boundary.

C1—25 to 32 inches; olive gray (5Y 5/2) sandy clay loam; many coarse distinct yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) mottles; massive; friable; about 4 percent coarse fragments; few roots; many coarse limestone fragments; some shale fragments; slight effervescence; moderately alkaline; clear wavy boundary.

C2—32 to 60 inches; gray (5Y 6/1) sandy clay loam; common coarse distinct yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) mottles; massive; friable; about 5 percent coarse fragments; few roots; many limestone and some shale fragments; strong effervescence; moderately alkaline.

The solum thickness and depth to free carbonates range from 24 to 36 inches. Reaction of the subsoil ranges from neutral to mildly alkaline.

The A horizon has value of 2 or 3 and chroma of 1 or less. The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is loam or sandy clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 or 2. The texture is sandy clay loam or loam.

Whalan series

The Whalan series consists of well drained soils on bedrock controlled uplands. They formed in a thin silty or loamy mantle over a mixture of loamy glacial till or drift and limestone residuum. Permeability is moderate in the upper loamy mantle. Slope ranges from 1 to 12 percent.

Whalan soils are similar to the Baytown, Ripon, and Copaston soils and are commonly adjacent to the Ripon and Ostrander soils. Baytown soils are fine silty and are underlain by sandstone bedrock. Ripon soils are fine silty and have a mollic epipedon. Copaston soils also have a mollic epipedon. Ostrander soils lack a lithic or paralithic contact within a depth of 40 inches.

Typical pedon of Whalan silt loam, 6 to 12 percent slopes, 2,590 feet east and 270 feet north of the southwest corner of section 34, T. 28 N., R. 20 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak medium granular structure; friable; slightly acid; abrupt smooth boundary.
A2—7 to 12 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak thick platy structure parting to weak fine subangular blocky; friable; slightly acid; clear smooth boundary.
B21t—12 to 18 inches; dark yellowish brown (10YR 4/4) loam; moderate fine subangular blocky structure; friable; slightly acid; clear smooth boundary.
IIB22t—18 to 26 inches; dark brown (7.5YR 4/4) loam, moderate fine and medium subangular blocky structure; firm; slightly acid; abrupt irregular boundary.
R—26 inches; very pale brown (10YR 7/3) level bedded limestone.

The thickness of the solum and depth to limestone bedrock range from 20 to 40 inches.

The A horizon has value of 2 through 4 and chroma of 1 through 3. The A2 horizon has value of 4 or 5 and chroma of 2. The A horizon is silt loam or loam and is neutral to medium acid. The B2t horizon has value of 4 or 5 and chroma of 3 through 6. It is loam or clay loam and is slightly acid to strongly acid. The IIB horizon has hue of 5YR, 7.5YR, or 10YR; value of 4 through 6; and chroma of 3 through 6. It is clay loam or loam and is slightly acid to mildly alkaline.

Zimmerman series

The Zimmerman series consists of excessively drained, rapidly permeable soils on outwash plains. They formed in deeply leached fine sandy material. Slope ranges from 0 to 25 percent.

Zimmerman soils are similar to Anoka and Sparta soils and are commonly adjacent to Isanti and Lino soils. Anoka soils have textural bands with an aggregate thickness of more than 6 inches that qualify for an argillic horizon. Sparta soils have a mollic epipedon. Isanti soils are very poorly drained, and Lino soils are somewhat poorly drained. Both occur in depressions.

Typical pedon of Zimmerman loamy fine sand, 0 to 6 percent slopes, 2,140 feet west and 500 feet north of the southeast corner of section 4, T. 30 N., R. 21 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loamy fine sand, brown (10YR 5/3) dry; very weak fine and medium granular structure; very friable; very strongly acid; abrupt smooth boundary.
A2—9 to 15 inches; grayish brown (10YR 5/2) loamy fine sand, pale brown (10YR 6/3) dry; very weak fine and medium subangular blocky structure; very friable; strongly acid; clear smooth boundary.
B2—15 to 37 inches; brown (10YR 5/3) fine sand; single grain; loose; medium acid; clear smooth boundary.
A'2—37 to 46 inches; pale brown (10YR 6/3) fine sand; single grain; loose; few splotches and streaks of dark yellowish brown (10YR 4/4); medium acid; abrupt wavy boundary.
A'2&B'2—46 to 55 inches; light yellowish brown (10YR 6/4) fine sand; single grain; loose; irregular and discontinuous dark brown (7.5YR 4/4) bands of loamy fine sand 1/4 to 1 inch thick; medium acid; abrupt wavy boundary.
B'2t—55 to 60 inches; dark brown (7.5YR 4/4) fine sand; massive; friable; dark brown (7.5YR 4/4) bands of loamy fine sand; few clay bridges between grains; slightly acid; abrupt wavy boundary.

Thickness of the solum is 40 to 70 inches. Reaction ranges from very strongly acid in the upper part to neutral in the lower part. The solum is dominantly loamy fine sand or fine sand.

The Ap horizon has value of 3 or 4 and chroma of 1 or 2. The A2 and A'2 horizons have value of 4 through 7 and chroma of 2 through 4. The B2 horizon has value of 4 through 6 and chroma of 3 through 5. The B'2t horizon has hue of 5YR, 7.5YR, or 10YR; value of 3 through 5; and chroma of 2 through 6. There is commonly an A&B' horizon which has colors intermediate between the A'2 and B'2t horizons. The B'2t and A&B' horizons have lamellae of fine sandy loam or very fine sand. Some pedons have a C horizon of fine sand or sand.

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. Mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Depth to rock. Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some

are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 37.5 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percolation. The downward movement of water through the soil.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, differences in slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified

size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	Less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the low lands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION

Month	Temperature[1]						Precipitation[1]				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[2]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	21.7	4.0	12.8	45	-25	0	.77	.22	1.20	2	10.1
February---	27.4	8.3	17.9	49	-21	0	.75	.17	1.20	2	9.0
March------	39.8	21.3	30.6	71	-10	17	1.48	.73	2.08	4	9.3
April------	56.8	35.4	46.1	86	16	33	2.32	1.49	3.06	6	3.1
May--------	69.4	47.0	58.2	89	27	271	3.74	2.14	5.05	8	.0
June-------	78.1	56.9	67.5	94	40	525	4.25	2.43	5.72	8	.0
July-------	82.5	61.8	72.2	95	47	688	3.44	2.11	4.63	6	.0
August-----	80.7	60.0	70.4	93	44	632	3.62	2.05	4.89	6	.0
September--	71.0	50.6	60.9	90	31	330	3.05	1.51	4.30	6	.0
October----	61.0	41.3	51.2	85	21	144	2.63	1.12	3.85	5	.3
November---	41.8	26.9	34.4	66	0	0	1.35	.55	1.98	3	3.7
December---	27.9	12.7	20.3	52	-17	0	1.01	.37	1.51	3	10.0
Year-----	54.8	35.5	45.2	95	-25	2,640	28.41	23.07	33.54	59	45.5

[1]Recorded in the period 1956-74 at St. Paul, Minnesota.

[2]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Temperature[1]		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 2	May 20	May 27
2 years in 10 later than--	April 27	May 14	May 21
5 years in 10 later than--	April 18	May 3	May 10
First freezing temperature in fall:			
1 year in 10 earlier than--	October 8	September 23	September 18
2 years in 10 earlier than--	October 14	September 29	September 22
5 years in 10 earlier than--	October 25	October 11	October 1

[1]Recorded in the period 1956-74 at St. Paul, Minnesota.

TABLE 3.--GROWING SEASON

Probability	Daily minimum temperature during growing season[1]		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	164	131	119
8 years in 10	172	141	127
5 years in 10	189	160	143
2 years in 10	205	179	159
1 year in 10	213	189	167

[1]Recorded in the period 1956-74 at St. Paul, Minnesota.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Washington County	Ramsey County	Total--	
				Area	Extent
		Acres	Acres	Acres	Pct
2	Ostrander silt loam, 0 to 2 percent slopes	1,590	0	1,590	0.5
2B	Ostrander silt loam, 2 to 6 percent slopes	5,525	0	5,525	1.6
2C	Ostrander silt loam, 6 to 12 percent slopes	1,485	0	1,485	0.4
7B	Hubbard loamy sand, 1 to 6 percent slopes	690	0	690	0.2
7C	Hubbard loamy sand, 6 to 12 percent slopes	1,060	0	1,060	0.3
7D	Hubbard loamy sand, 12 to 18 percent slopes	2,060	0	2,060	0.6
8	Sparta loamy sand, 0 to 2 percent slopes	5,985	0	5,985	1.7
8B	Sparta loamy sand, 2 to 6 percent slopes	875	30	905	0.3
8C	Sparta loamy sand, 6 to 15 percent slopes	465	0	465	0.1
12C	Emmert loamy coarse sand, 3 to 15 percent slopes	1,745	10	1,755	0.5
12D	Emmert gravelly loamy coarse sand, 15 to 25 percent slopes	2,945	0	2,945	0.8
49	Antigo silt loam, 0 to 2 percent slopes	12,715	25	12,740	3.5
49B	Antigo silt loam, 2 to 6 percent slopes	13,930	220	14,150	4.0
49C	Antigo silt loam, 6 to 12 percent slopes	4,540	115	4,655	1.3
49D	Antigo silt loam, 12 to 18 percent slopes	890	35	925	0.3
75	Bluffton loam	1,790	520	2,310	0.7
100B	Copaston loam, 0 to 6 percent slopes	1,220	30	1,250	0.4
100C	Copaston loam, 6 to 12 percent slopes	490	25	515	0.1
113	Webster loam	1,435	30	1,465	0.4
120	Brill silt loam	3,945	90	4,035	1.1
123	Dundas fine sandy loam	4,560	500	5,060	1.4
132B	Hayden fine sandy loam, 2 to 6 percent slopes	1,470	1,065	2,535	0.7
132C	Hayden fine sandy loam, 6 to 12 percent slopes	1,360	2,425	3,785	1.1
132D	Hayden fine sandy loam, 12 to 25 percent slopes	380	1,015	1,395	0.4
151	Burkhardt sandy loam, 0 to 3 percent slopes	440	0	440	0.1
151B	Burkhardt sandy loam, 3 to 9 percent slopes	370	0	370	0.1
153B	Santiago silt loam, 2 to 6 percent slopes	14,425	525	14,950	4.2
153C	Santiago silt loam, 6 to 15 percent slopes	7,250	175	7,425	2.1
155B	Chetek sandy loam, 0 to 6 percent slopes	3,960	375	4,335	1.2
155C	Chetek sandy loam, 6 to 12 percent slopes	7,490	530	8,020	2.3
155D	Chetek sandy loam, 12 to 25 percent slopes	3,640	1,350	4,990	1.4
158B	Zimmerman loamy fine sand, 0 to 6 percent slopes	875	3,750	4,625	1.3
158C	Zimmerman loamy fine sand, 6 to 12 percent slopes	1,015	685	1,700	0.5
158D	Zimmerman loamy fine sand, 12 to 25 percent slopes	1,065	580	1,645	0.5
159	Anoka loamy fine sand, 0 to 3 percent slopes	1,745	485	2,230	0.6
159B	Anoka loamy fine sand, 3 to 9 percent slopes	1,030	695	1,725	0.5
161	Isanti loamy fine sand	1,430	635	2,065	0.6
162	Lino loamy fine sand	2,695	1,125	3,820	1.1
166	Ronneby fine sandy loam	1,045	170	1,215	0.3
169B	Braham loamy fine sand, 1 to 6 percent slopes	430	640	1,070	0.3
169C	Braham loamy fine sand, 6 to 15 percent slopes	370	750	1,120	0.3
170	Blomford loamy fine sand	760	275	1,035	0.3
174C	Gale silt loam, 6 to 15 percent slopes	365	0	365	0.1
174F	Gale silt loam, 25 to 50 percent slopes	510	0	510	0.1
177B	Gotham loamy sand, 1 to 6 percent slopes	960	30	990	0.3
177C	Gotham loamy sand, 6 to 12 percent slopes	720	105	825	0.2
177D	Gotham loamy sand, 12 to 20 percent slopes	560	65	625	0.2
189	Auburndale silt loam	490	170	660	0.2
225	Nessel fine sandy loam, 1 to 4 percent slopes	3,595	640	4,235	1.2
259B	Grays silt loam, 2 to 6 percent slopes	0	175	175	*
264	Freeon silt loam, 1 to 4 percent slopes	1,695	85	1,780	0.5
265	Soderville loamy fine sand	355	340	695	0.2
266	Freer silt loam	3,585	130	3,715	1.1
298	Richwood silt loam, 0 to 2 percent slopes	970	0	970	0.3
298B	Richwood silt loam, 2 to 6 percent slopes	1,315	125	1,440	0.4
301B	Lindstrom silt loam, 2 to 4 percent slopes	2,985	30	3,015	0.9
302B	Rosholt sandy loam, 1 to 6 percent slopes	1,685	295	1,980	0.6
302C	Rosholt sandy loam, 6 to 15 percent slopes	1,240	250	1,490	0.4
325	Prebish loam	845	115	960	0.3
327	Dickman sandy loam, 0 to 2 percent slopes	240	0	240	0.1
327B	Dickman sandy loam, 2 to 6 percent slopes	885	0	885	0.3
327C	Dickman sandy loam, 6 to 12 percent slopes	595	0	595	0.2
329	Chaska silt loam	1,025	1,875	2,900	0.8
340B	Whalan silt loam, 1 to 6 percent slopes	575	0	575	0.2
340C	Whalan silt loam, 6 to 12 percent slopes	740	0	740	0.2
342B	Kingsley sandy loam, 2 to 6 percent slopes	3,200	995	4,195	1.2
342C	Kingsley sandy loam, 6 to 12 percent slopes	8,915	2,125	11,040	3.1
342D	Kingsley sandy loam, 12 to 18 percent slopes	3,470	740	4,210	1.2
342E	Kingsley sandy loam, 18 to 30 percent slopes	235	195	430	0.1

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Washington County	Ramsey County	Total-- Area	Total-- Extent
		Acres	Acres	Acres	Pct
367B	Campia silt loam, 0 to 8 percent slopes	1,395	40	1,435	0.4
408	Faxon silt loam	350	50	400	0.1
411	Waukegan silt loam, 0 to 2 percent slopes	1,795	235	2,030	0.6
411B	Waukegan silt loam, 2 to 6 percent slopes	3,955	285	4,240	1.2
411C	Waukegan silt loam, 6 to 12 percent slopes	640	75	715	0.2
449	Crystal Lake silt loam, 1 to 3 percent slopes	675	55	730	0.2
452	Comstock silt loam	2,420	105	2,525	0.7
453B	Demontreville loamy fine sand, 2 to 6 percent slopes	2,335	240	2,575	0.7
453C	Demontreville loamy fine sand, 6 to 12 percent slopes	2,205	325	2,530	0.7
453D	Demontreville loamy fine sand, 12 to 25 percent slopes	1,350	220	1,570	0.4
454B	Mahtomedi loamy sand, 0 to 6 percent slopes	5,265	260	5,525	1.6
454C	Mahtomedi loamy sand, 6 to 12 percent slopes	4,195	535	4,730	1.3
454D	Mahtomedi loamy sand, 12 to 25 percent slopes	4,475	480	4,955	1.4
454F	Mahtomedi loamy sand, 25 to 40 percent slopes	585	580	1,165	0.3
456	Barronett silt loam	785	750	1,535	0.4
460B	Baytown silt loam, 1 to 6 percent slopes	1,925	0	1,925	0.5
460C	Baytown silt loam, 6 to 12 percent slopes	675	0	675	0.2
468	Otter silt loam	310	0	310	0.1
472B	Channahon silt loam, 1 to 6 percent slopes	250	0	250	0.1
472C	Channahon silt loam, 6 to 12 percent slopes	565	0	565	0.2
472D	Channahon silt loam, 12 to 18 percent slopes	435	0	435	0.1
481	Kratka fine sandy loam	430	85	515	0.1
488F	Brodale flaggy loam, 20 to 50 percent slopes	785	0	785	0.2
504B	Duluth silt loam, 1 to 6 percent slopes	425	115	540	0.2
504C	Duluth silt loam, 6 to 12 percent slopes	1,425	215	1,640	0.5
504D	Duluth silt loam, 12 to 25 percent slopes	825	195	1,020	0.3
507	Poskin silt loam	2,015	85	2,100	0.6
529	Ripon silt loam, 1 to 2 percent slopes	2,785	0	2,785	0.8
529B	Ripon silt loam, 2 to 6 percent slopes	1,440	0	1,440	0.4
529C	Ripon silt loam, 6 to 12 percent slopes	1,175	0	1,175	0.3
540	Seelyeville muck	2,975	2,780	5,755	1.6
541	Rifle muck	2,055	1,995	4,050	1.2
543	Markey muck	825	585	1,410	0.4
544	Cathro muck	1,315	395	1,710	0.5
552	Kerston muck	0	485	485	0.1
852B	Urban land-Copaston complex, 0 to 8 percent slopes	1,945	1,850	3,795	1.1
857	Urban land-Waukegan complex, 0 to 3 percent slopes	75	4,125	4,200	1.2
857C	Urban land-Waukegan complex, 3 to 15 percent slopes	125	3,730	3,855	1.1
858	Urban land-Chetek complex, 0 to 3 percent slopes	1,940	50	1,990	0.6
858C	Urban land-Chetek complex, 3 to 15 percent slopes	885	7,110	7,995	2.8
859B	Urban land-Zimmerman complex, 1 to 8 percent slopes	5,290	7,505	12,795	3.5
860C	Urban land-Hayden-Kingsley complex, 3 to 15 percent slopes	2,390	6,255	8,645	2.5
860D	Urban land-Hayden-Kingsley complex, 15 to 25 percent slopes	70	900	970	0.3
861C	Urban land-Kingsley complex, 3 to 15 percent slopes	2,210	9,835	12,045	3.3
861D	Urban land-Kingsley complex, 15 to 25 percent slopes	90	575	665	0.2
862	Urban land-Dundas complex, 1 to 4 percent slopes	365	520	885	0.3
863	Urban land-Lino complex, 0 to 3 percent slopes	0	1,535	1,535	0.4
896C	Mahtomedi-Kingsley complex, 3 to 12 percent slopes	1,205	495	1,700	0.5
896D	Mahtomedi-Kingsley complex, 12 to 25 percent slopes	445	370	815	0.2
896F	Mahtomedi-Kingsley complex, 25 to 40 percent slopes	825	310	1,135	0.3
1013	Pits,quarry	160	10	170	*
1027	Udorthents, wet substratum	385	6,015	6,400	1.8
1029	Pits, gravel	1,440	500	1,940	0.6
1033	Udifluvents	860	250	1,110	0.3
1039	Urban land	555	9,280	9,835	2.8
1040	Udorthents	385	295	680	0.2
1055	Aquolls and Histosols, ponded	2,885	1,095	3,980	1.1
1813B	Lino Variant loamy fine sand, 2 to 6 percent slopes	385	260	645	0.2
1819F	Dorerton-Rock outcrop complex, 25 to 65 percent slopes	735	485	1,220	0.3
1820F	Mahtomedi Variant-Rock outcrop complex, 25 to 60 percent slopes	745	15	760	0.2
1821	Algansee loamy sand	955	495	1,450	0.4
1827	Waukegan Variant silt loam, 0 to 2 percent slopes	985	0	985	0.3
1827B	Waukegan Variant silt loam, 2 to 9 percent slopes	245	0	245	0.1
1847	Barronett silt loam, sandy substratum	690	0	690	0.2
1848B	Sparta loamy sand, bedrock substratum, 0 to 6 percent slopes	330	0	330	0.1
	Total land area	249,600	102,400	352,000	100.0
	Water greater than 40 acres	18,560	7,040	25,600	
	Total	268,160	109,440	377,600	

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass	Corn silage
	Bu	Bu	Bu	Ton	AUM*	AUM*	Ton
2--- Ostrander	95	28	80	3.8	5.7	3.5	15
2B--- Ostrander	90	27	75	3.6	5.4	3.5	15
2C--- Ostrander	80	24	70	3.2	4.7	3.3	14
7B--- Hubbard	45	18	40	2.0	2.5	2.0	9
7C--- Hubbard	40	15	35	1.7	2.2	1.6	8
7D--- Hubbard	---	---	---	1.5	2.0	1.3	---
8--- Sparta	50	15	40	2.0	3.0	2.4	6
8B--- Sparta	50	15	40	2.0	3.0	2.4	6
8C--- Sparta	---	---	---	2.0	2.5	2.0	---
12C--- Emmert	30	---	10	2.0	2.0	2.6	5
12D--- Emmert	---	---	---	1.5	2.0	1.5	---
49--- Antigo	70	21	56	2.8	4.1	3.5	15
49B--- Antigo	70	21	56	2.8	4.1	3.5	15
49C--- Antigo	60	18	48	2.4	3.6	3.5	13
49D--- Antigo	50	15	40	2.0	3.0	2.4	12
75--- Bluffton	75	22	60	3.0	4.5	3.5	10
100B--- Copaston	55	18	45	2.7	4.0	3.0	6
100C--- Copaston	50	15	40	2.5	3.7	1.6	6
113--- Webster	85	30	70	3.5	5.0	3.5	16
120--- Brill	80	24	64	3.2	4.7	3.5	12
123--- Dundas	85	30	65	4.0	5.0	3.8	16

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass	Corn silage
	Bu	Bu	Bu	Ton	AUM*	AUM*	Ton
132B--Hayden	85	33	75	4.5	6.5	3.5	16
132C--Hayden	75	31	60	4.5	6.5	3.5	14
132D--Hayden	---	---	---	3.0	4.5	3.0	---
151--Burkhardt	55	16	44	2.2	3.3	2.5	11
151B--Burkhardt	50	15	40	2.0	3.0	2.4	9
153B--Santiago	85	26	68	3.4	5.1	3.5	16
153C--Santiago	80	24	64	3.2	4.7	3.4	16
155B--Chetek	55	18	50	3.0	4.5	3.0	11
155C--Chetek	45	14	45	2.5	3.8	2.0	9
155D--Chetek	---	---	---	2.5	3.8	2.7	---
158B--Zimmerman	50	18	45	2.2	3.3	2.2	10
158C--Zimmerman	45	16	40	1.8	2.8	1.9	9
158D--Zimmerman	---	---	---	1.5	2.3	1.6	---
159--Anoka	60	22	55	3.5	5.0	2.5	13
159B--Anoka	60	20	50	3.0	4.5	2.5	11
161--Isanti	55	20	45	3.5	5.0	3.3	10
162--Lino	60	20	50	2.7	4.0	3.0	12
166--Ronneby	80	28	64	3.2	4.7	3.4	14
169B--Braham	60	20	50	3.0	4.2	2.5	11
169C--Braham	50	18	40	2.7	3.3	2.2	10
170--Blomford	60	24	50	3.0	3.7	3.0	13
174C--Gale	65	20	52	2.6	3.9	2.8	13
174F--Gale	---	---	---	2.0	3.2	2.8	---

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass	Corn silage
	Bu	Bu	Bu	Ton	AUM*	AUM*	Ton
177B, 177C---------- Gotham	50	15	40	2.0	3.0	2.4	6
177D---------- Gotham	---	---	---	1.8	2.7	2.0	---
189---------- Auburndale	70	21	56	2.8	4.1	3.3	6
225---------- Nessel	85	28	75	4.5	6.5	3.3	17
259B---------- Grays	85	28	80	4.5	7.0	---	18
264---------- Freeon	80	24	64	3.2	4.7	3.5	12
265---------- Soderville	60	20	50	3.0	3.0	3.5	12
266---------- Freer	80	20	64	3.2	4.7	3.5	11
298---------- Richwood	95	28	80	3.8	5.7	3.5	16
298B---------- Richwood	95	28	80	3.8	5.7	3.5	16
301B---------- Lindstrom	95	28	80	3.8	5.7	3.5	16
302B---------- Rosholt	65	20	52	2.6	3.9	3.0	12
302C---------- Rosholt	60	18	50	2.4	3.6	3.0	11
325---------- Prebish	75	22	65	3.0	4.5	3.5	14
327---------- Dickman	55	22	45	2.5	3.7	2.5	11
327B---------- Dickman	50	20	45	3.0	3.7	2.3	10
327C---------- Dickman	45	18	40	3.0	3.7	1.2	9
329---------- Chaska	---	---	---	3.0	3.5	3.0	---
340B---------- Whalan	70	24	60	2.8	4.1	3.0	12
340C---------- Whalan	60	18	48	2.4	3.6	2.7	10
342B---------- Kingsley	70	29	60	3.2	4.8	3.0	14
342C---------- Kingsley	60	25	55	3.0	4.5	3.0	12
342D---------- Kingsley	50	21	48	2.5	3.7	3.0	10

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass	Corn silage
	Bu	Bu	Bu	Ton	AUM*	AUM*	Ton
342E---------- Kingsley	---	---	---	2.2	3.3	2.6	---
367B---------- Campia	90	27	72	3.6	5.4	3.5	17
408---------- Faxon	---	---	---	---	---	---	---
411---------- Waukegan	80	24	64	3.2	4.7	3.5	12
411B---------- Waukegan	80	24	64	3.2	4.7	3.5	12
411C---------- Waukegan	70	21	56	2.8	4.1	3.2	10
449---------- Crystal Lake	90	27	72	3.6	5.4	3.5	15
452---------- Comstock	85	26	68	3.4	5.1	3.5	13
453B---------- Demontreville	60	18	48	2.4	3.6	2.4	11
453C---------- Demontreville	50	15	40	2.0	3.0	2.4	9
453D---------- Demontreville	---	---	---	1.5	2.2	1.0	---
454B, 454C---------- Mahtomedi	45	14	36	2.0	3.0	1.2	5
454D---------- Mahtomedi	---	---	---	---	---	1.0	---
454F---------- Mahtomedi	---	---	---	---	---	0.8	---
456---------- Barronett	90	27	70	3.5	5.4	3.5	15
460B---------- Baytown	70	21	56	2.8	4.1	3.3	10
460C---------- Baytown	60	18	48	2.4	3.6	2.5	8
468---------- Otter	75	22	60	3.0	4.5	3.3	11
472B---------- Channahon	55	16	45	2.2	3.3	2.4	7
472C---------- Channahon	45	14	37	1.8	2.7	2.1	6
472D---------- Channahon	---	---	---	1.8	2.7	---	---
481---------- Kratka	55	20	65	2.5	3.8	3.5	12
488F---------- Brodale	---	---	---	---	---	0.6	---

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass	Corn silage
	Bu	Bu	Bu	Ton	AUM*	AUM*	Ton
504B, 504C---- Duluth	65	20	52	2.6	3.9	3.0	9
504D---- Duluth	---	---	---	1.6	2.5	2.5	---
507---- Poskin	80	24	70	3.5	4.7	3.5	13
529---- Ripon	75	22	60	3.0	4.5	3.5	11
529B---- Ripon	75	22	60	3.0	4.5	3.5	11
529C---- Ripon	65	20	52	2.6	3.9	3.0	9
540---- Seelyeville	---	---	---	---	---	3.3	11
541---- Rifle	---	---	---	---	---	2.5	11
543---- Markey	50	15	40	2.0	3.0	2.4	8
544---- Cathro	75	26	55	2.5	3.2	3.3	15
896C---- Mahtomedi-Kingsley	50	15	40	2.4	3.6	1.9	8
896D---- Mahtomedi-Kingsley	---	---	---	---	---	1.6	---
896F---- Mahtomedi-Kingsley	---	---	---	---	---	1.2	---
1813B---- Lino Variant	65	18	50	2.5	3.5	2.5	8
1821---- Algansee	70	21	56	2.8	4.1	3.2	10
1827---- Waukegan Variant	70	21	56	2.8	4.1	3.3	10
1827B---- Waukegan Variant	70	21	56	2.8	4.1	3.3	10
1847---- Barronett, sandy substratum	70	21	56	2.8	4.1	3.3	10
1848B---- Sparta, bedrock substratum	50	15	40	2.0	3.0	2.2	8

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Common trees	Site index	
7B, 7C---------- Hubbard	3s	Slight	Slight	Severe	Moderate	Red pine----------	56	Red pine, white spruce, eastern white pine, jack pine.
						Eastern white pine--	54	
						Jack pine----------	58	
						White spruce-------	54	
						Bur oak----------	40	
7D---------- Hubbard	4s	Moderate	Severe	Severe	Slight	Red pine----------	49	Red pine, jack pine, eastern white pine.
						Eastern white pine--	47	
						Jack pine----------	52	
						White spruce-------	48	
						Bur oak----------	40	
12C---------- Emmert	3s	Slight	Slight	Severe	Moderate	Red pine----------	56	Red pine, eastern white pine, jack pine.
						Eastern white pine--	54	
						Jack pine----------	60	
						White spruce-------	55	
12D---------- Emmert	4s	Moderate	Severe	Severe	Slight	Red pine----------	49	Jack pine, red pine.
						Eastern white pine--	46	
						Jack pine----------	54	
						White spruce-------	52	
49, 49B, 49C------- Antigo	2o	Slight	Slight	Slight	Moderate	Sugar maple--------	63	Eastern white pine, red pine, white spruce.
						American basswood---	---	
						Northern red oak----	---	
						Eastern white pine--	---	
49D---------- Antigo	2r	Moderate	Moderate	Slight	Moderate	Sugar maple--------	63	Eastern white pine, red pine, white spruce.
						American basswood---	---	
						Northern red oak----	---	
						Eastern white pine--	---	
75---------- Bluffton	3w	Slight	Severe	Severe	Severe	White spruce-------	53	White spruce, black ash, eastern cottonwood.
						Quaking aspen------	75	
						Black ash----------	45	
						American elm-------	50	
120---------- Brill	2o	Slight	Slight	Slight	Moderate	Sugar maple--------	60	White spruce, eastern white pine, red pine.
						Yellow birch-------	---	
						American basswood---	---	
123---------- Dundas	3w	Slight	Moderate	Moderate	Severe	Eastern cottonwood--	86	Eastern cottonwood, black ash.
						American elm-------	55	
						Green ash----------	50	
						Black ash----------	50	
132B, 132C--------- Hayden	2o	Slight	Slight	Slight	Moderate	Northern red oak----	69	Black walnut, northern red oak, American basswood, silver maple, white oak.
						American basswood---	69	
						Sugar maple--------	---	
						Black walnut-------	62	
						Eastern white pine--	58	
						White oak----------	62	
132D---------- Hayden	2r	Moderate	Moderate	Slight	Moderate	Northern red oak----	69	Black walnut, northern red oak, American basswood, silver maple, white oak.
						American basswood---	69	
						Sugar maple--------	---	
						Eastern white pine--	64	
						White oak----------	62	

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Common trees	Site index	
153B, 153C Santiago	2o	Slight	Slight	Slight	Moderate	Northern red oak Sugar maple American basswood White ash Red maple Red pine Quaking aspen	63 --- --- --- --- --- ---	Red pine, eastern white pine, white spruce.
155B, 155C Chetek	3s	Slight	Slight	Slight	Slight	Red pine Jack pine White oak	55 --- ---	Red pine, jack pine.
155D Chetek	3f	Moderate	Moderate	Slight	Slight	Red pine Jack pine Black oak White oak	55 --- --- ---	Red pine, jack pine.
158B, 158C Zimmerman	3s	Slight	Slight	Moderate	Moderate	Red pine Eastern white pine Jack pine White spruce	56 54 60 59	Red pine, white spruce.
158D Zimmerman	4s	Moderate	Moderate	Moderate	Slight	Red pine Eastern white pine Jack pine White spruce	50 50 52 54	Red pine, jack pine.
159, 159B Anoka	3s	Slight	Slight	Moderate	Moderate	Eastern white pine Northern pin oak	55 55	Eastern white pine, jack pine, red pine.
162 Lino	3s	Slight	Slight	Moderate	Moderate	Eastern white pine American elm White spruce	54 --- 59	White spruce, red pine.
166 Ronneby	2d	Slight	Slight	Slight	Severe	Quaking aspen Eastern white pine Jack pine Northern red oak American basswood Sugar maple	75 57 51 62 62 57	White spruce, northern red oak.
169B, 169C Braham	2s	Slight	Slight	Moderate	Moderate	Northern red oak Quaking aspen Red pine Eastern white pine Jack pine White spruce	64 75 60 55 64 59	Red pine, eastern white pine, white spruce.
170 Blomford	2w	Slight	Severe	Moderate	Severe	Quaking aspen	74	White spruce, eastern white pine.
174C Gale	2o	Slight	Slight	Slight	Moderate	Northern red oak Sugar maple White oak	65 --- ---	Red pine, eastern white pine, white spruce.
174F Gale	2r	Severe	Severe	Slight	Moderate	Northern red oak Sugar maple White oak	65 --- ---	Red pine, eastern white pine, white spruce.
177B, 177C Gotham	3s	Slight	Slight	Moderate	Moderate	Red pine Jack pine Northern red oak	53 54 54	Red pine, jack pine.
177D Gotham	3s	Moderate	Moderate	Moderate	Moderate	Red pine Jack pine Northern red oak	53 54 54	Red pine, jack pine.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Common trees	Site index	
189---------- Auburndale	3w	Slight	Severe	Moderate	Severe	Red maple---------- American basswood--- American elm--------- Balsam fir---------- Black ash---------- Balsam poplar--------	55 --- 50 --- 45 70	White spruce, black spruce, poplar.
225---------- Nessel	2o	Slight	Slight	Slight	Moderate	Northern red oak---- American basswood--- Black walnut--------- Sugar maple--------- Quaking aspen-------- Eastern cottonwood--	64 68 60 57 75 90	Red pine, eastern white pine, northern red oak, white spruce, black walnut, American basswood.
259B---------- Grays	1o	Slight	Slight	Slight	Moderate	Northern red oak---- Sugar maple--------- White ash----------	72 --- ---	Eastern white pine, red pine, white spruce.
265---------- Soderville	3s	Slight	Moderate	Moderate	Moderate	Red pine---------- Eastern white pine-- Jack pine---------- White spruce---------	56 54 60 59	White spruce, red pine, white spruce.
266---------- Freer	2o	Slight	Slight	Slight	Severe	White spruce-------- Quaking aspen-------- American basswood--- Northern red oak---- Sugar maple--------- Eastern white pine--	58 75 62 62 62 59	White spruce, northern red oak, American basswood.
302B, 302C--------- Rosholt	2o	Slight	Slight	Slight	Moderate	Sugar maple--------- American basswood--- Yellow birch--------	60 --- ---	Red pine, eastern white pine.
325---------- Prebish	3w	Slight	Moderate	Moderate	Severe	White spruce-------- Black ash----------	53 45	White spruce, black spruce.
340B, 340C--------- Whalan	2o	Slight	Slight	Slight	Severe	Eastern white pine-- Northern red oak---- White oak---------- Black walnut--------	58 60 60 55	Northern red oak, white oak, silver maple, eastern white pine.
342B, 342C--------- Kingsley	2o	Slight	Slight	Slight	Moderate	Red pine---------- Eastern white pine-- Jack pine---------- White spruce-------- Quaking aspen--------	60 57 62 60 75	Red pine, white spruce, jack pine.
342D, 342E--------- Kingsley	3r	Moderate	Moderate	Moderate	Moderate	Red pine---------- Eastern white pine-- Jack pine---------- White spruce-------- Quaking aspen-------- Northern red oak----	55 55 60 55 70 55	Red pine, northern red oak, white spruce, jack pine.
367B---------- Campia	2o	Slight	Slight	Slight	Moderate	Northern red oak---- Sugar maple--------- White ash---------- American basswood---	65 --- --- ---	Eastern white pine, red pine, white spruce.
449---------- Crystal Lake	2o	Slight	Slight	Slight	Moderate	Sugar maple--------- American basswood--- Yellow birch--------	60 --- ---	Eastern white pine, red pine, white spruce.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Common trees	Site index	
452---------- Comstock	2o	Slight	Slight	Slight	Moderate	Red maple---------- American basswood--- Quaking aspen--------	65 --- ---	Eastern white pine, white spruce.
453B, 453C--------- Demontreville	3s	Slight	Slight	Moderate	Slight	Red pine---------- Eastern white pine-- Jack pine---------- White spruce--------	56 54 60 57	Red pine, white spruce, jack pine.
453D---------- Demontreville	3s	Moderate	Moderate	Moderate	Slight	Red pine---------- Eastern white pine-- Jack pine---------- White spruce--------	56 54 60 57	Red pine, white spruce, jack pine.
454B, 454C--------- Mahtomedi	3s	Slight	Slight	Severe	Slight	Red pine---------- White spruce-------- Jack pine---------- Eastern white pine--	55 57 60 55	Red pine, white spruce, jack pine.
454D, 454F--------- Mahtomedi	3s	Moderate	Moderate	Severe	Slight	Red pine---------- White spruce-------- Jack pine---------- Eastern white pine--	55 57 60 55	Red pine, white spruce, jack pine.
456---------- Barronett	5w	Slight	Severe	Severe	Severe	Tamarack---------- Black ash---------- Quaking aspen-------	30 --- ---	White spruce, black spruce.
472B, 472C--------- Channahon	3d	Slight	Slight	Moderate	Slight	Northern red oak---- White oak---------- Northern white-cedar Shagbark hickory----	55 --- --- ---	Eastern white pine, red pine.
472D---------- Channahon	3d	Severe	Moderate	Moderate	Slight	Northern red oak---- White oak---------- Northern white-cedar Shagbark hickory----	55 --- --- ---	Eastern white pine, red pine.
504B, 504C--------- Duluth	2o	Slight	Slight	Slight	Moderate	Quaking aspen------- Red pine---------- Eastern white pine-- Jack pine---------- White spruce--------	70 60 50 60 58	Red pine, northern red oak, white spruce, American basswood.
504D---------- Duluth	2r	Moderate	Moderate	Slight	Moderate	Quaking aspen------- Red pine---------- Eastern white pine-- Jack pine---------- White spruce--------	70 60 50 60 58	Red pine, northern red oak, white spruce, American basswood.
507---------- Poskin	2o	Slight	Slight	Slight	Moderate	Red pine---------- American basswood--- Eastern white pine--	60 --- ---	White spruce, eastern white pine.
896C*: Mahtomedi---------	3s	Slight	Slight	Severe	Moderate	Red pine---------- White spruce-------- Jack pine---------- Eastern white pine--	55 57 60 55	Red pine, white spruce, jack pine.
Kingsley----------	2o	Slight	Slight	Slight	Moderate	Red pine---------- Eastern white pine-- Jack pine---------- White spruce-------- Quaking aspen-------	60 57 62 60 75	Red pine, white spruce, jack pine.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Common trees	Site index	
896D*, 896F*:								
Mahtomedi	3s	Moderate	Moderate	Severe	Moderate	Red pine	55	Red pine, white spruce, jack pine.
						White spruce	57	
						Jack pine	60	
						Eastern white pine	55	
Kingsley	3r	Moderate	Moderate	Moderate	Moderate	Red pine	55	Red pine, northern red oak, white spruce, jack pine.
						Eastern white pine	55	
						Jack pine	60	
						White spruce	55	
						Quaking aspen	70	
						Northern red oak	55	
1813B Lino Variant	3s	Slight	Slight	Moderate	Moderate	Red pine	56	Red pine, white spruce.
						Jack pine	60	
						Eastern white pine	54	
						White spruce	59	
1819F*:								
Dorerton	3f	Moderate	Severe	Moderate	Slight	Northern red oak	55	Northern red oak, eastern white pine, white spruce, black walnut.
						Eastern white pine	50	
						White oak	50	
						Bur oak	50	
						American basswood	50	
						Black cherry	50	
						Quaking aspen	60	
Rock outcrop.								
1820F*:								
Mahtomedi Variant	4s	Severe	Severe	Severe	Slight	Red pine	55	Red pine, jack pine.
						Jack pine	60	
						Eastern white pine	55	
						White spruce	53	
Rock outcrop.								
1821 Algansee	3s	Slight	Slight	Moderate	Slight	Quaking aspen	60	White spruce, eastern cottonwood, Norway spruce, black spruce, Austrian pine.
						Silver maple	78	
						Swamp white oak	---	
						White ash	51	
						Sugar maple	53	
						Red maple	56	
						American sycamore	---	
1847 Barronett, sandy substratum	3w	Slight	Severe	Moderate	Severe	Red maple	55	Red maple, white spruce.
						Black ash	---	

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--			
	8-15	16-25	26-35	>35
2, 2B, 2C--------- Ostrander	Gray dogwood, Tatarian honeysuckle, lilac.	Siberian crabapple, Amur maple, eastern redcedar, northern white-cedar.	Eastern white pine, green ash, common hackberry.	Eastern cottonwood, American elm.
7B, 7C---------- Hubbard	Eastern redcedar, Siberian crabapple, northern white-cedar, silver buffaloberry, Russian-olive.	Common hackberry, bur oak, jack pine.	---	---
7D. Hubbard				
8, 8B, 8C--------- Sparta	Siberian peashrub, lilac, Siberian crabapple, Russian-olive.	Norway spruce, common hackberry, red pine, eastern white pine, jack pine.	---	---
12C--------- Emmert	Eastern redcedar, Siberian crabapple, Russian-olive, northern white-cedar, Tatarian honeysuckle, Siberian peashrub, silver buffaloberry.	Common hackberry, bur oak, jack pine, ponderosa pine.	---	---
12D. Emmert				
49, 49B, 49C, 49D- Antigo	Northern white-cedar, common ninebark, silky dogwood, lilac, Tatarian honeysuckle.	White spruce, Norway spruce, common hackberry.	Eastern white pine, red pine, green ash.	---
75---------- Bluffton	Northern white-cedar, medium purple willow, redosier dogwood, Tatarian honeysuckle, lilac.	Amur maple, white spruce.	Green ash, black ash	Golden willow.
100B, 100C-------- Copaston	Eastern redcedar, Siberian crabapple, silver buffaloberry, Tatarian honeysuckle.	Red pine, common hackberry, bur oak.	---	---
113---------- Webster	Northern white-cedar, redosier dogwood, medium purple willow, Tatarian honeysuckle.	Siberian crabapple, Amur maple, green ash, eastern white pine, white spruce.	Silver maple, golden willow.	Eastern cottonwood.
120---------- Brill	Northern white-cedar, common ninebark, silky dogwood, lilac, Siberian crabapple.	White spruce, Norway spruce, eastern redcedar, common hackberry.	Eastern white pine, red pine, green ash.	---
123---------- Dundas	Northern white-cedar, Tatarian honeysuckle, lilac, redosier dogwood.	Norway spruce, eastern white pine, Amur maple.	Black ash, golden willow, green ash, silver maple.	Eastern cottonwood.
132B, 132C-------- Hayden	Gray dogwood, Tatarian honeysuckle, lilac.	Siberian crabapple, Amur maple, northern white-cedar, white spruce.	Eastern white pine, green ash, common hackberry, ponderosa pine.	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--			
	8-15	16-25	26-35	>35
132D. Hayden				
151, 151B--- Burkhardt	Siberian peashrub, lilac, eastern redcedar, Russian-olive, Siberian crabapple, silver buffaloberry.	Norway spruce, common hackberry, eastern white pine, red pine, jack pine.	---	---
153B, 153C--- Santiago	Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce, Amur maple, green ash, Siberian crabapple.	Eastern white pine, red pine.	---
155B, 155C, 155D-- Chetek	Eastern redcedar, northern white-cedar, Russian-olive, silver buffaloberry.	Norway spruce, Siberian peashrub, lilac.	Eastern white pine, red pine, jack pine.	---
158B, 158C--- Zimmerman	Northern white-cedar, Russian-olive, Siberian crabapple, Amur honeysuckle, Tatarian honeysuckle.	Eastern white pine, ponderosa pine, red pine, common hackberry, bur oak.	---	---
158D. Zimmerman				
159, 159B--- Anoka	Eastern redcedar, northern white-cedar, Siberian crabapple, Russian-olive, Tatarian honeysuckle, Siberian peashrub.	Eastern white pine, common hackberry.	---	---
161--- Isanti	Northern white-cedar, medium purple willow, redosier dogwood, Tatarian honeysuckle, lilac.	Black spruce, Amur maple.	Golden willow, green ash, silver maple.	Eastern cottonwood.
162--- Lino	Northern white-cedar, medium purple willow, Tatarian honeysuckle, lilac.	Amur maple, white spruce.	Green ash, golden willow.	---
166--- Ronneby	Northern white-cedar, lilac, medium purple willow, Tatarian honeysuckle.	Amur maple, white spruce.	Green ash, silver maple.	---
169B, 169C--- Braham	Tatarian honeysuckle, Siberian crabapple, lilac, flowering dogwood.	Eastern redcedar, red pine, bur oak, northern white-cedar, white spruce, common hackberry.	Green ash---	---
170--- Blomford	Northern white-cedar, medium purple willow, redosier dogwood, Tatarian honeysuckle.	Amur maple, white spruce.	Green ash, black ash, golden willow.	---
174C, 174F--- Gale	Northern white-cedar, common ninebark, lilac, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
177B, 177C, 177D-- Gotham	Lilac, eastern redcedar, Tatarian honeysuckle, silver buffaloberry.	Norway spruce, Siberian peashrub, common hackberry.	Eastern white pine, red pine, jack pine.	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--			
	8-15	16-25	26-35	>35
189---------- Auburndale	Northern white-cedar, lilac, tall purple willow.	White spruce, Amur maple.	Golden willow, green ash.	Eastern cottonwood.
225---------- Nessel	Lilac, redosier dogwood, Tatarian honeysuckle.	Northern white-cedar, Amur maple, white spruce, Siberian crabapple.	Green ash, common hackberry, red pine.	Silver maple.
259B---------- Grays	Common ninebark, silky dogwood, lilac.	Norway spruce, white spruce, northern white-cedar, Amur maple.	Eastern white pine, red pine, common hackberry.	---
264---------- Freeon	Northern white-cedar, Amur maple, American cranberrybush.	White spruce, black spruce, Norway spruce, Siberian crabapple.	Eastern white pine, red pine, green ash.	---
265---------- Soderville	Eastern redcedar, Russian-olive, Tatarian honeysuckle, northern white-cedar.	Eastern white pine, common hackberry.	---	---
266---------- Freer	Gray dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple.	Common hackberry------	---
298, 298B--------- Richwood	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce, Siberian crabapple, Amur maple.	Eastern white pine, red pine, common hackberry.	---
301B---------- Lindstrom	Redosier dogwood, Tatarian honeysuckle, lilac.	Eastern redcedar, northern white-cedar, blue spruce, Siberian crabapple, Amur maple.	Eastern white pine, green ash, common hackberry.	Eastern cottonwood.
302B, 302C-------- Rosholt	Lilac, Siberian crabapple, silky dogwood, Tatarian honeysuckle.	Siberian peashrub, Norway spruce, eastern redcedar.	Eastern white pine, jack pine, red pine, green ash.	---
325. Prebish				
327, 327B, 327C--- Dickman	Siberian crabapple, Amur honeysuckle, lilac.	Eastern redcedar, blue spruce, Austrian pine, northern white-cedar, common hackberry, red pine, white spruce, bur oak.	Green ash----------	---
329---------- Chaska	Eastern redcedar, common chokecherry, Tatarian honeysuckle.	Common hackberry, black spruce, green ash, ponderosa pine, Siberian crabapple.	Eastern cottonwood, golden willow.	---
340B, 340C-------- Whalan	Siberian crabapple, gray dogwood, Tatarian honeysuckle, lilac.	Eastern redcedar, eastern white pine, white spruce, red pine, common hackberry.	Green ash----------	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--			
	8-15	16-25	26-35	>35
342B, 342C--------- Kingsley	Siberian crabapple, redosier dogwood, Amur honeysuckle, lilac.	Eastern redcedar, northern white-cedar, white spruce, red pine, common hackberry, bur oak.	Green ash----------	---
342D, 342E. Kingsley				
367B---------- Campia	Northern white-cedar, common ninebark, lilac, silky dogwood, Siberian crabapple.	White spruce, Norway spruce, eastern redcedar.	Eastern white pine, red pine, green ash.	---
408---------- Faxon	Tall purple willow, Tatarian honeysuckle, Siberian peashrub, redosier dogwood.	Russian-olive---------	---	Eastern cottonwood, golden willow.
411, 411B, 411C--- Waukegan	Siberian crabapple, lilac, American plum, Tatarian honeysuckle.	Eastern redcedar, red pine, northern white-cedar, common hackberry, white spruce.	Green ash----------	Eastern cottonwood.
449---------- Crystal Lake	Northern white-cedar, common ninebark, lilac, silky dogwood, Siberian crabapple, Tatarian honeysuckle.	White spruce, Norway spruce, eastern redcedar.	Eastern white pine, red pine, green ash.	---
452---------- Comstock	Northern white-cedar, redosier dogwood, nannyberry viburnum.	Amur maple, white spruce.	Eastern white pine, silver maple, green ash, golden willow.	Eastern cottonwood.
453B, 453C-------- Demontreville	Eastern redcedar, northern white-cedar, Russian-olive, Siberian crabapple, Tatarian honeysuckle, Siberian peashrub.	Red pine, common hackberry, bur oak.	---	---
453D. Demontreville				
454B, 454C-------- Mahtomedi	Eastern redcedar, Russian-olive, Siberian crabapple, northern white-cedar.	Eastern white pine, red pine, common hackberry, bur oak.	---	---
454D, 454F. Mahtomedi				
456---------- Barronett	Northern white-cedar, redosier dogwood, lilac, medium purple willow, Tatarian honeysuckle.	White spruce, Amur maple, eastern white pine.	Silver maple, green ash.	Eastern cottonwood.
460B, 460C-------- Baytown	Siberian crabapple, redosier dogwood, Tatarian honeysuckle.	Eastern redcedar, northern white-cedar, common hackberry, bur oak.	Green ash----------	---
468. Otter				

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--			
	8-15	16-25	26-35	>35
472B, 472C--------- Channahon	Siberian crabapple, lilac, Tatarian honeysuckle.	Eastern white pine, red pine, eastern redcedar, common hackberry.	Green ash----------	---
472D. Channahon				
481. Kratka				
488F. Brodale				
504B, 504C--------- Duluth	---	Northern white-cedar, Siberian crabapple, Amur maple, eastern redcedar.	Green ash, common hackberry.	---
504D. Duluth				
507---------- Poskin	Redosier dogwood, nannyberry viburnum.	Northern white-cedar, white spruce.	Eastern white pine, jack pine, silver maple, green ash.	---
529, 529B, 529C--- Ripon	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
540---------- Seelyeville	Common ninebark, gray dogwood, nannyberry viburnum, medium purple willow, northern white-cedar.	Black spruce, Amur maple, white spruce.	Laurel willow, black ash.	Eastern cottonwood.
541---------- Rifle	Silky dogwood, white spruce, black spruce.	Austrian pine, nannyberry viburnum, eastern white pine.	Northern white-cedar, Norway spruce.	Carolina poplar.
543---------- Markey	Silky dogwood, white spruce, Amur privet.	Austrian pine, eastern white pine.	Scotch pine, northern white-cedar.	Carolina poplar, green ash.
544---------- Cathro	Tatarian honeysuckle, silky dogwood, white spruce, Amur privet.	Eastern white pine, Austrian pine.	Northern white-cedar, Norway spruce.	---
552---------- Kerston	Amur privet, silky dogwood, white spruce.	Austrian pine, eastern white pine, nannyberry viburnum.	Northern white-cedar	Tamarack, Carolina poplar.
852B*: Urban land.				
Copaston--------- Eastern redcedar, Siberian crabapple, silver buffaloberry, Tatarian honeysuckle.		Red pine, common hackberry, bur oak.	---	---
857*, 857C*: Urban land.				
Waukegan--------- Siberian crabapple, lilac, American plum, Tatarian honeysuckle.		Eastern redcedar, red pine, northern white-cedar, common hackberry, white spruce.	Green ash----------	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--			
	8-15	16-25	26-35	>35
858*, 858C*: Urban land.				
Chetek	Eastern redcedar, northern white-cedar, Russian-olive, silver buffaloberry.	Norway spruce, Siberian peashrub, lilac.	Eastern white pine, red pine, jack pine.	---
859B*: Urban land.				
Zimmerman	Northern white-cedar, Russian-olive, Siberian crabapple, Amur honeysuckle, Tatarian honeysuckle.	Eastern white pine, ponderosa pine, red pine, common hackberry, bur oak.	---	---
860C*: Urban land.				
Hayden	Gray dogwood, Tatarian honeysuckle, lilac.	Siberian crabapple, Amur maple, northern white-cedar, white spruce.	Eastern white pine, green ash, common hackberry, ponderosa pine.	Eastern cottonwood.
Kingsley	Siberian crabapple, redosier dogwood, Amur honeysuckle, lilac.	Eastern redcedar, northern white-cedar, white spruce, red pine, common hackberry, bur oak.	Green ash	---
860D*: Urban land.				
Hayden.				
Kingsley.				
861C*: Urban land.				
Kingsley	Siberian crabapple, redosier dogwood, Amur honeysuckle, lilac.	Eastern redcedar, northern white-cedar, white spruce, red pine, common hackberry, bur oak.	Green ash	---
861D*: Urban land.				
Kingsley.				
862*: Urban land.				
Dundas	Northern white-cedar, Tatarian honeysuckle, lilac, redosier dogwood.	Norway spruce, eastern white pine, Amur maple.	Black ash, golden willow, green ash, silver maple.	Eastern cottonwood.
863*: Urban land.				
Lino	Northern white-cedar, medium purple willow, Tatarian honeysuckle, lilac.	Amur maple, white spruce.	Green ash, golden willow.	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--			
	8-15	16-25	26-35	>35
896C*:				
Mahtomedi	Eastern redcedar, Russian-olive, Siberian crabapple, northern white-cedar.	Eastern white pine, red pine, common hackberry, bur oak.	---	---
Kingsley	Siberian crabapple, redosier dogwood, Amur honeysuckle, lilac.	Eastern redcedar, northern white-cedar, white spruce, red pine, common hackberry, bur oak.	Green ash	---
896D*, 896F*:				
Mahtomedi.				
Kingsley.				
1013*.				
Pits, quarry				
1027*.				
Udorthents				
1029*.				
Pits, gravel				
1033*.				
Udifluvents				
1039*.				
Urban land				
1040*.				
Udorthents				
1055*.				
Aquolls and Histosols				
1813B----------	Northern white-cedar,	Eastern white pine,	---	---
Lino Variant	Siberian peashrub, eastern redcedar, Russian-olive, Siberian crabapple, Tatarian honeysuckle.	red pine, jack pine, common hackberry.		
1819F*:				
Dorerton.				
Rock outcrop.				
1820F*:				
Mahtomedi Variant.				
Rock outcrop.				
1821----------	Northern white-cedar,	Eastern white pine,	---	---
Algansee	Siberian peashrub, eastern redcedar, Russian-olive, Siberian crabapple, Tatarian honeysuckle.	red pine, jack pine, common hackberry.		
1827, 1827B-------	Siberian crabapple,	Eastern redcedar,	Green ash	---
Waukegan Variant	Amur honeysuckle, lilac, Tatarian honeysuckle.	northern white-cedar, Norway spruce, Scotch pine, common hackberry, bur oak, white spruce.		

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--			
	8-15	16-25	26-35	>35
1847---------- Barronett	Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, silver maple.	---
1848B---------- Sparta	Eastern redcedar, lilac.	Norway spruce, Siberian peashrub, red pine, eastern white pine, jack pine.	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
2--- Ostrander	Slight	Slight	Slight	Slight.
2B--- Ostrander	Slight	Slight	Moderate: slope.	Slight.
2C--- Ostrander	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
7B--- Hubbard	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
7C--- Hubbard	Moderate: too sandy, slope.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
7D--- Hubbard	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.
8--- Sparta	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
8B--- Sparta	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy, slope.	Moderate: too sandy.
8C--- Sparta	Moderate: too sandy, slope.	Moderate: too sandy, slope.	Severe: slope.	Moderate: too sandy.
12C--- Emmert	Moderate: slope, small stones.	Moderate: small stones, slope.	Severe: slope, small stones.	Moderate: small stones.
12D--- Emmert	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: slope, small stones.
49--- Antigo	Slight	Slight	Slight	Slight.
49B--- Antigo	Slight	Slight	Moderate: slope.	Slight.
49C--- Antigo	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
49D--- Antigo	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
75--- Bluffton	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
100B--- Copaston	Slight	Slight	Severe: depth to rock.	Slight.
100C--- Copaston	Moderate: slope.	Moderate: slope.	Severe: depth to rock, slope.	Slight.
113--- Webster	Severe: wetness.	Moderate: wetness, too clayey.	Severe: wetness.	Moderate: wetness, too clayey.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
120--Brill	Slight	Slight	Slight	Slight.
123--Dundas	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
132B--Hayden	Slight	Slight	Moderate: slope.	Slight.
132C--Hayden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
132D--Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
151--Burkhardt	Slight	Slight	Slight	Slight.
151B--Burkhardt	Slight	Slight	Severe: slope.	Slight.
153B--Santiago	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight.
153C--Santiago	Moderate: slope, percs slowly.	Moderate: slope.	Severe: slope.	Slight.
155B--Chetek	Slight	Slight	Moderate: slope.	Slight.
155C--Chetek	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
155D--Chetek	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
158B--Zimmerman	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
158C--Zimmerman	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
158D--Zimmerman	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.
159--Anoka	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
159B--Anoka	Moderate: too sandy.	Moderate: too sandy.	Severe: slope.	Moderate: too sandy.
161--Isanti	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
162--Lino	Moderate: wetness, too sandy.	Moderate: wetness, too sandy.	Moderate: too sandy, wetness.	Moderate: too sandy.
166--Ronneby	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness, percs slowly.	Slight.
169B--Braham	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
169C---- Braham	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
170---- Blomford	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, too sandy.
174C---- Gale	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
174F---- Gale	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
177B---- Gotham	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
177C---- Gotham	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
177D---- Gotham	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope, too sandy.
189---- Auburndale	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
225---- Nessel	Slight----	Slight----	Moderate: slope.	Slight.
259B---- Grays	Slight----	Slight----	Moderate: slope.	Slight.
264---- Freeon	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
265---- Soderville	Moderate: wetness, too sandy.	Moderate: wetness, too sandy.	Moderate: slope, too sandy, wetness.	Moderate: too sandy.
266---- Freer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
298---- Richwood	Slight----	Slight----	Slight----	Slight.
298B---- Richwood	Slight----	Slight----	Moderate: slope.	Slight.
301B---- Lindstrom	Slight----	Slight----	Moderate: slope.	Slight.
302B---- Rosholt	Slight----	Slight----	Moderate: slope, small stones.	Slight.
302C---- Rosholt	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
325---- Prebish	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
327---- Dickman	Slight----	Slight----	Slight----	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
327B---------- Dickman	Slight----------	Slight----------	Moderate: slope.	Slight.
327C---------- Dickman	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
329---------- Chaska	Severe: wetness, floods.	Moderate: wetness.	Severe: wetness, floods.	Moderate: wetness.
340B---------- Whalan	Moderate: percs slowly.	Slight----------	Moderate: depth to rock, slope, percs slowly.	Slight.
340C---------- Whalan	Moderate: slope, percs slowly.	Moderate: slope.	Severe: slope.	Slight.
342B---------- Kingsley	Moderate: percs slowly.	Slight----------	Moderate: slope, small stones, percs slowly.	Slight.
342C---------- Kingsley	Moderate: slope, percs slowly.	Moderate: slope.	Severe: slope.	Slight.
342D, 342E---------- Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
367B---------- Campia	Slight----------	Slight----------	Moderate: slope.	Slight.
408---------- Faxon	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
411---------- Waukegan	Slight----------	Slight----------	Slight----------	Slight.
411B---------- Waukegan	Slight----------	Slight----------	Moderate: slope.	Slight.
411C---------- Waukegan	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
449---------- Crystal Lake	Slight----------	Slight----------	Moderate: slope.	Slight.
452---------- Comstock	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
453B---------- Demontreville	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy, slope.	Moderate: too sandy.
453C---------- Demontreville	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
453D---------- Demontreville	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.
454B---------- Mahtomedi	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
454C---- Mahtomedi	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
454D---- Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.
454F---- Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
456---- Barronett	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
460B---- Baytown	Slight----	Slight----	Moderate: slope, depth to rock.	Slight.
460C---- Baytown	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
468---- Otter	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
472B---- Channahon	Slight----	Slight----	Severe: depth to rock.	Slight.
472C---- Channahon	Moderate: slope.	Moderate: slope.	Severe: depth to rock, slope.	Slight.
472D---- Channahon	Severe: slope.	Severe: slope.	Severe: depth to rock, slope.	Moderate: slope.
481---- Kratka	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
488F---- Brodale	Severe: slope, large stones.	Severe: slope, large stones.	Severe: large stones, slope.	Severe: large stones, slope.
504B---- Duluth	Moderate: percs slowly.	Slight----	Moderate: slope, percs slowly.	Slight.
504C---- Duluth	Moderate: slope, percs slowly.	Moderate: slope.	Severe: slope.	Slight.
504D---- Duluth	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
507---- Poskin	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
529---- Ripon	Slight----	Slight----	Slight----	Slight.
529B---- Ripon	Slight----	Slight----	Moderate: depth to rock, slope.	Slight.
529C---- Ripon	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
540--- Seelyeville	Severe: excess humus, wetness, floods.	Severe: excess humus, wetness.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.
541--- Rifle	Severe: floods, wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness, floods.	Severe: wetness, excess humus.
543--- Markey	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.
544--- Cathro	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.
552--- Kerston	Severe: floods, wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, floods, wetness.	Severe: wetness, excess humus.
852B*: Urban land.				
Copaston---	Slight---	Slight---	Severe: depth to rock.	Slight.
857*: Urban land.				
Waukegan---	Slight---	Slight---	Slight---	Slight.
857C*: Urban land.				
Waukegan---	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
858*: Urban land.				
Chetek---	Slight---	Slight---	Slight---	Slight.
858C*: Urban land.				
Chetek---	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
859B*: Urban land.				
Zimmerman---	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
860C*: Urban land.				
Hayden---	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
860C*:				
Kingsley	Moderate: slope, percs slowly.	Moderate: slope.	Severe: slope.	Slight.
860D*:				
Urban land.				
Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
861C*:				
Urban land.				
Kingsley	Moderate: slope, percs slowly.	Moderate: slope.	Severe: slope.	Slight.
861D*:				
Urban land.				
Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
862*:				
Urban land.				
Dundas	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
863*:				
Urban land.				
Lino	Moderate: wetness, too sandy.	Moderate: wetness, too sandy.	Moderate: too sandy, wetness.	Moderate: too sandy.
896C*:				
Mahtomedi	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
Kingsley	Moderate: slope, percs slowly.	Moderate: slope.	Severe: slope.	Slight.
896D*:				
Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.
Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
896F*:				
Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1013*.				
Pits, quarry				

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
1027*. Udorthents				
1029*. Pits, gravel				
1033*. Udifluvents				
1039*. Urban land				
1040*. Udorthents				
1055*. Aquolls and Histosols				
1813B---- Lino Variant	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy, slope.	Moderate: too sandy.
1819F*: Dorerton----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Rock outcrop.				
1820F*: Mahtomedi Variant----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Rock outcrop.				
1821---- Algansee	Severe: floods, wetness.	Moderate: wetness, too sandy.	Severe: wetness.	Moderate: wetness, too sandy.
1827---- Waukegan Variant	Slight----	Slight----	Moderate: depth to rock.	Slight.
1827B---- Waukegan Variant	Slight----	Slight----	Moderate: depth to rock, slope.	Slight.
1847---- Barronett, sandy substratum	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
1848B---- Sparta, bedrock substratum	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
2, 2B---------- Ostrander	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
2C---------- Ostrander	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
7B, 7C---------- Hubbard	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
7D---------- Hubbard	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
8, 8B---------- Sparta	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
8C---------- Sparta	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
12C---------- Emmert	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
12D---------- Emmert	Very poor.	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
49, 49B---------- Antigo	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
49C, 49D---------- Antigo	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
75---------- Bluffton	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
100B, 100C---------- Copaston	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
113---------- Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
120---------- Brill	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
123---------- Dundas	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
132B---------- Hayden	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
132C---------- Hayden	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
132D---------- Hayden	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
151, 151B---------- Burkhardt	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
153B---------- Santiago	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
153C---------- Santiago	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

TABLE 9.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
155B, 155C---------- Chetek	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
155D---------- Chetek	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
158B, 158C, 158D--- Zimmerman	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
159, 159B---------- Anoka	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
161---------- Isanti	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
162---------- Lino	Poor	Fair	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor.
166---------- Ronneby	Fair	Fair	Good	Good	Good	Good	Good	Fair	Good	Good.
169B, 169C---------- Braham	Fair	Good	Good	Fair	Good	Very poor.	Very poor.	Fair	Good	Very poor.
170---------- Blomford	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
174C---------- Gale	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
174F---------- Gale	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
177B, 177C, 177D--- Gotham	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
189---------- Auburndale	Good	Good	Fair	Fair	Good	Good	Good	Good	Fair	Good.
225---------- Nessel	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
259B---------- Grays	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
264---------- Freeon	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
265---------- Soderville	Poor	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Poor	Fair.
266---------- Freer	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
298, 298B---------- Richwood	Good	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
301B---------- Lindstrom	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
302B---------- Rosholt	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
302C---------- Rosholt	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
325---------- Prebish	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.

TABLE 9.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
327, 327B, 327C---- Dickman	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
329---------- Chaska	Very poor.	Fair	Good	Fair	Fair	Good	Good	Fair	Fair	Good.
340B, 340C--------- Whalan	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
342B---------- Kingsley	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
342C, 342D--------- Kingsley	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
342E---------- Kingsley	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
367B---------- Campia	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
408---------- Faxon	Fair	Fair	Fair	Poor	Poor	Good	Fair	Fair	Poor	Fair.
411, 411B---------- Waukegan	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
411C---------- Waukegan	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
449---------- Crystal Lake	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
452---------- Comstock	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
453B---------- Demontreville	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
453C---------- Demontreville	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.
453D---------- Demontreville	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.
454B, 454C--------- Mahtomedi	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
454D, 454F--------- Mahtomedi	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
456---------- Barronett	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good.
460B, 460C--------- Baytown	Fair	Good	Fair	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
468---------- Otter	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good.
472B, 472C, 472D--- Channahon	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.
481---------- Kratka	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.
488F---------- Brodale	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Poor	Very poor.

TABLE 9.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
504B, 504C--------- Duluth	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
504D--------- Duluth	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
507--------- Poskin	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
529, 529B--------- Ripon	Good	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
529C--------- Ripon	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
540--------- Seelyeville	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
541--------- Rifle	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
543--------- Markey	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Fair.
544--------- Cathro	Poor	Fair	Fair	Fair	Fair	Good	Good	Poor	Poor	Good.
552--------- Kerston	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
852B*: Urban land.										
Copaston----------	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
857*: Urban land.										
Waukegan----------	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
857C*: Urban land.										
Waukegan----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
858*, 858C*: Urban land.										
Chetek----------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
859B*: Urban land.										
Zimmerman---------	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
860C*: Urban land.										
Hayden----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
860C*:										
Kingsley	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
860D*:										
Urban land.										
Hayden	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Kingsley	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
861C*:										
Urban land.										
Kingsley	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
861D*:										
Urban land.										
Kingsley	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
862*:										
Urban land.										
Dundas	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
863*:										
Urban land.										
Lino	Poor	Fair	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor.
896C*:										
Mahtomedi	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
Kingsley	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
896D*, 896F*:										
Mahtomedi	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Kingsley	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
1013*.										
Pits, quarry										
1027*.										
Udorthents										
1029*.										
Pits, gravel										
1033*.										
Udifluvents										
1039*.										
Urban land										
1040*.										
Udorthents										

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
1055*. Aquolls and Histosols										
1813B---------- Lino Variant	Poor	Fair	Fair	Poor	Fair	Poor	Very poor.	Poor	Fair	Poor.
1819F*: Dorerton----------	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.
Rock outcrop.										
1820F*: Mahtomedi Variant-	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Rock outcrop.										
1821---------- Algansee	Poor	Fair	Fair	Poor	Poor	Fair	Fair	Fair	Poor	Fair.
1827, 1827B--------- Waukegan Variant	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
1847---------- Barronett, sandy substratum	Good	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
1848B---------- Sparta, bedrock substratum	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
2--- Ostrander	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.	Slight.
2B--- Ostrander	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
2C--- Ostrander	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, low strength, frost action.	Moderate: slope.
7B--- Hubbard	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: too sandy.
7C--- Hubbard	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: too sandy, slope.
7D--- Hubbard	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
8--- Sparta	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: too sandy.
8B--- Sparta	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: too sandy.
8C--- Sparta	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: too sandy, slope.
12C--- Emmert	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: too sandy, small stones.
12D--- Emmert	Severe: slope, cutbanks cave.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, too sandy, small stones.
49--- Antigo	Severe: cutbanks cave.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.	Slight.
49B--- Antigo	Severe: cutbanks cave.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: low strength.	Slight.
49C--- Antigo	Severe: cutbanks cave.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.	Moderate: slope.
49D--- Antigo	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.	Severe: slope.
75--- Bluffton	Severe: wetness, floods.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness, low strength.	Severe: floods, wetness.
100B--- Copaston	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: thin layer.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
100C---------- Copaston	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: thin layer.
113---------- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action, wetness.	Severe: wetness.
120---------- Brill	Severe: cutbanks cave.	Moderate: shrink-swell, low strength.	Moderate: wetness, shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: frost action, low strength.	Slight.
123---------- Dundas	Severe: wetness.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: frost action, low strength.	Moderate: wetness.
132B---------- Hayden	Slight---------	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: low strength.	Slight.
132C---------- Hayden	Moderate: slope.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.	Moderate: slope.
132D---------- Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.	Severe: slope.
151---------- Burkhardt	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
151B---------- Burkhardt	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
153B---------- Santiago	Severe: cutbanks cave.	Moderate: low strength.	Moderate: low strength.	Moderate: slope, low strength.	Moderate: low strength, frost action.	Slight.
153C---------- Santiago	Severe: cutbanks cave.	Moderate: slope, low strength.	Moderate: slope, low strength.	Severe: slope.	Moderate: low strength, frost action, slope.	Moderate: slope.
155B---------- Chetek	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
155C---------- Chetek	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
155D---------- Chetek	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
158B---------- Zimmerman	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: too sandy.
158C---------- Zimmerman	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: too sandy, slope.
158D---------- Zimmerman	Severe: slope, cutbanks cave.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
159---------- Anoka	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Moderate: too sandy.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
159B---------- Anoka	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Moderate: too sandy.
161---------- Isanti	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
162---------- Lino	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: frost action, wetness.	Moderate: too sandy.
166---------- Ronneby	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Moderate: wetness.
169B---------- Braham	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: low strength.	Moderate: too sandy.
169C---------- Braham	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope.	Moderate: too sandy, slope.
170---------- Blomford	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
174C---------- Gale	Moderate: depth to rock, slope.	Moderate: slope, low strength, shrink-swell.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Severe: frost action, low strength.	Moderate: slope, thin layer.
174F---------- Gale	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: frost action, slope, low strength.	Severe: slope.
177B---------- Gotham	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: too sandy.
177C---------- Gotham	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope, too sandy.
177D---------- Gotham	Severe: slope, cutbanks cave.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
189---------- Auburndale	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods.
225---------- Nessel	Moderate: wetness.	Moderate: shrink-swell, low strength.	Moderate: wetness, shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength, frost action.	Slight.
259B---------- Grays	Moderate: wetness.	Moderate: shrink-swell, low strength.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell, slope, low strength.	Severe: frost action, low strength.	Slight.
264---------- Freeon	Severe: wetness.	Moderate: wetness, shrink-swell, low strength.	Severe: wetness.	Severe: wetness.	Moderate: wetness, shrink-swell, low strength.	Moderate: wetness.
265---------- Soderville	Severe: wetness, cutbanks cave.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: too sandy.
266---------- Freer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Moderate: wetness.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
298, 298B--------- Richwood	Severe: cutbanks cave.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: frost action.	Slight.
301B-------------- Lindstrom	Slight---------	Slight---------	Slight---------	Slight---------	Severe: frost action.	Slight.
302B-------------- Rosholt	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Moderate: small stones.
302C-------------- Rosholt	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: frost action, slope.	Moderate: slope, small stones.
325--------------- Prebish	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action, floods.	Severe: wetness, floods.
327--------------- Dickman	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
327B-------------- Dickman	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
327C-------------- Dickman	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
329--------------- Chaska	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, frost action.	Severe: floods.
340B-------------- Whalan	Moderate: depth to rock.	Slight---------	Moderate: depth to rock.	Slight---------	Moderate: low strength, frost action.	Moderate: thin layer.
340C-------------- Whalan	Moderate: depth to rock, slope.	Moderate: slope.	Moderate: depth to rock, slope.	Severe: slope.	Moderate: slope, low strength, frost action.	Moderate: slope, thin layer.
342B-------------- Kingsley	Slight---------	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: small stones.
342C-------------- Kingsley	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope, small stones.
342D, 342E-------- Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
367B-------------- Campia	Slight---------	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: slope, low strength, shrink-swell.	Severe: low strength, frost action.	Slight.
408--------------- Faxon	Severe: wetness, floods, depth to rock.	Severe: wetness, floods.	Severe: wetness, floods, depth to rock.	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods.
411--------------- Waukegan	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
411B-------------- Waukegan	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
411C-------------- Waukegan	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
449--Crystal Lake	Moderate: wetness.	Moderate: low strength.	Moderate: wetness, low strength.	Moderate: low strength.	Severe: frost action, low strength.	Slight.
452--Comstock	Severe: wetness, cutbanks cave.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: frost action, low strength.	Moderate: wetness.
453B--Demontreville	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength.	Moderate: too sandy.
453C--Demontreville	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, low strength.	Moderate: too sandy, slope.
453D--Demontreville	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
454B--Mahtomedi	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: too sandy.
454C--Mahtomedi	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: too sandy, slope.
454D, 454F--Mahtomedi	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
456--Barronett	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods.
460B--Baytown	Severe: cutbanks cave.	Slight	Moderate: depth to rock.	Moderate: slope.	Severe: frost action.	Moderate: thin layer.
460C--Baytown	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope, depth to rock.	Severe: slope.	Severe: frost action.	Moderate: slope, thin layer.
468--Otter	Severe: wetness, floods.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: wetness, floods, low strength.	Severe: wetness.
472B--Channahon	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: thin layer.
472C--Channahon	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: thin layer.
472D--Channahon	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: thin layer, slope.
481--Kratka	Severe: floods, wetness, cutbanks cave.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness, low strength.	Severe: floods, wetness.
488F--Brodale	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
504B--Duluth	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, slope, low strength.	Moderate: frost action, low strength.	Slight.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
504C---------- Duluth	Moderate: slope.	Moderate: shrink-swell, slope, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
504D---------- Duluth	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
507---------- Poskin	Severe: wetness, cutbanks cave.	Severe: floods, wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: frost action.	Moderate: wetness.
529---------- Ripon	Severe: depth to rock.	Moderate: depth to rock, shrink-swell.	Severe: depth to rock.	Moderate: depth to rock, shrink-swell.	Severe: frost action, low strength.	Moderate: thin layer.
529B---------- Ripon	Severe: depth to rock.	Moderate: depth to rock, shrink-swell.	Severe: depth to rock.	Moderate: depth to rock, slope, shrink-swell.	Severe: frost action, low strength.	Moderate: thin layer.
529C---------- Ripon	Severe: depth to rock.	Moderate: depth to rock, shrink-swell, slope.	Severe: depth to rock.	Severe: slope.	Severe: frost action, low strength.	Moderate: thin layer, slope.
540---------- Seelyeville	Severe: wetness, excess humus, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, excess humus.
541---------- Rifle	Severe: wetness, excess humus, floods.	Severe: wetness, low strength, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, low strength, floods.	Severe: excess humus, wetness, floods.
543---------- Markey	Severe: wetness, floods, cutbanks cave.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.	Severe: low strength, wetness, floods.	Severe: excess humus, wetness, floods.
544---------- Cathro	Severe: wetness, floods, excess humus.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, frost action, floods.	Severe: excess humus, wetness, floods.
552---------- Kerston	Severe: wetness, excess humus, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: excess humus, wetness, floods.
852B*: Urban land.						
Copaston---------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: thin layer.
857*: Urban land.						
Waukegan---------	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
857C*: Urban land.						
Waukegan---------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
858*: Urban land.						
Chetek	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
858C*: Urban land.						
Chetek	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
859B*: Urban land.						
Zimmerman	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: too sandy.
860C*: Urban land.						
Hayden	Moderate: slope.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.	Moderate: slope.
Kingsley	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope, small stones.
860D*: Urban land.						
Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.	Severe: slope.
Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
861C*: Urban land.						
Kingsley	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope, small stones.
861D*: Urban land.						
Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
862*: Urban land.						
Dundas	Severe: wetness.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: frost action, low strength.	Moderate: wetness.
863*: Urban land.						
Lino	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: frost action, wetness.	Moderate: too sandy.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
896C*:						
Mahtomedi	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: too sandy, slope.
Kingsley	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope, small stones.
896D*, 896F*:						
Mahtomedi	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1013*. Pits, quarry						
1027*. Udorthents						
1029*. Pits, gravel						
1033*. Udifluvents						
1039*. Urban land						
1040*. Udorthents						
1055*. Aquolls and Histosols						
1813B---------- Lino Variant	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Moderate: slope.	Moderate: frost action.	Moderate: too sandy.
1819F*:						
Dorerton	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Rock outcrop.						
1820F*:						
Mahtomedi Variant	Severe: slope, cutbanks cave.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Rock outcrop.						
1821---------- Algansee	Severe: wetness, floods, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Moderate: too sandy, wetness.
1827, 1827B------- Waukegan Variant	Severe: depth to rock, cutbanks cave.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: thin layer.
1847---------- Barronett, sandy substratum	Severe: wetness, floods, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1848B---------- Sparta, bedrock substratum	Severe: cutbanks cave.	Slight---------	Moderate: depth to rock.	Slight---------	Slight---------	Moderate: too sandy.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
2---------- Ostrander	Slight----------	Moderate: seepage.	Slight----------	Slight----------	Good.
2B---------- Ostrander	Slight----------	Moderate: slope, seepage.	Slight----------	Slight----------	Good.
2C---------- Ostrander	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.	Fair: slope.
7B---------- Hubbard	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
7C---------- Hubbard	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
7D---------- Hubbard	Severe: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage, slope.	Poor: too sandy, slope, seepage.
8, 8B---------- Sparta	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
8C---------- Sparta	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
12C---------- Emmert	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
12D---------- Emmert	Severe: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
49, 49B---------- Antigo	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, small stones.
49C---------- Antigo	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, small stones.
49D---------- Antigo	Severe: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: slope, seepage.	Poor: too sandy, small stones, slope.
75---------- Bluffton	Severe: wetness, floods, percs slowly.	Severe: wetness, floods, seepage.	Severe: wetness, floods.	Severe: wetness, floods, seepage.	Poor: wetness.
100B---------- Copaston	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim.
100C---------- Copaston	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
113---------- Webster	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
120---------- Brill	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, small stones, seepage.
123---------- Dundas	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
132B---------- Hayden	Moderate: percs slowly.	Moderate: slope, seepage.	Moderate: too clayey.	Slight----------	Fair: too clayey.
132C---------- Hayden	Moderate: percs slowly, slope.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
132D---------- Hayden	Severe: slope.	Severe: slope.	Moderate: slope, too clayey.	Severe: slope.	Poor: slope.
151, 151B---------- Burkhardt	Slight----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: too sandy, seepage.
153B---------- Santiago	Severe: percs slowly.	Moderate: seepage, slope.	Slight----------	Slight----------	Good.
153C---------- Santiago	Severe: percs slowly.	Severe: slope.	Slight----------	Moderate: slope.	Fair: slope.
155B---------- Chetek	Slight----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: small stones.
155C---------- Chetek	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: small stones, slope.
155D---------- Chetek	Severe: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage, slope.	Poor: slope.
158B---------- Zimmerman	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
158C---------- Zimmerman	Moderate: slope.	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
158D---------- Zimmerman	Severe: slope.	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: slope, seepage.	Poor: too sandy, seepage, slope.
159, 159B---------- Anoka	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Fair: too sandy.
161---------- Isanti	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
162---------- Lino	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, too sandy, wetness.	Severe: seepage, wetness.	Poor: too sandy, seepage.
166---------- Ronneby	Severe: wetness, percs slowly.	Severe: wetness, seepage.	Severe: wetness.	Severe: wetness, seepage.	Fair: wetness.
169B---------- Braham	Moderate: percs slowly.	Moderate: seepage, slope.	Slight----------	Severe: seepage.	Good.
169C---------- Braham	Moderate: percs slowly, slope.	Severe: slope.	Slight----------	Severe: seepage.	Fair: slope, too clayey.
170---------- Blomford	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness, seepage.	Severe: seepage, wetness.	Poor: wetness.
174C---------- Gale	Severe: depth to rock.	Severe: slope, seepage.	Severe: depth to rock, seepage.	Severe: seepage.	Poor: area reclaim.
174F---------- Gale	Severe: depth to rock, slope.	Severe: slope, seepage.	Severe: depth to rock, slope, seepage.	Severe: seepage, slope.	Poor: slope, area reclaim.
177B---------- Gotham	Slight----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
177C---------- Gotham	Moderate: slope.	Severe: slope, seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
177D---------- Gotham	Severe: slope.	Severe: slope, seepage.	Severe: seepage.	Severe: seepage, slope.	Poor: slope, seepage.
189---------- Auburndale	Severe: wetness, floods, percs slowly.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: wetness.
225---------- Nessel	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey.
259B---------- Grays	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness, seepage.	Severe: seepage, wetness.	Good.
264---------- Freeon	Severe: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Poor: wetness.
265---------- Soderville	Severe: wetness.	Severe: wetness, seepage.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
266---------- Freer	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
298, 298B---------- Richwood	Slight----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too clayey.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
301B---------- Lindstrom	Slight----------	Moderate: slope, seepage.	Slight----------	Slight----------	Good.
302B---------- Rosholt	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: small stones, seepage.
302C---------- Rosholt	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: small stones, seepage.
325---------- Prebish	Severe: wetness, percs slowly, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
327, 327B---------- Dickman	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
327C---------- Dickman	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
329---------- Chaska	Severe: wetness, floods.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: wetness.
340B---------- Whalan	Severe: depth to rock.	Moderate: depth to rock, slope.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.
340C---------- Whalan	Severe: depth to rock.	Severe: slope.	Severe: depth to rock.	Moderate: slope, depth to rock.	Poor: area reclaim.
342B---------- Kingsley	Severe: percs slowly.	Moderate: slope.	Slight----------	Slight----------	Good.
342C---------- Kingsley	Severe: percs slowly.	Severe: slope.	Slight----------	Moderate: slope.	Fair: slope.
342D, 342E---------- Kingsley	Severe: slope, percs slowly.	Severe: slope.	Moderate: slope.	Severe: slope.	Poor: slope.
367B---------- Campia	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
408---------- Faxon	Severe: wetness, depth to rock, floods.	Severe: wetness, depth to rock, floods.	Severe: wetness, depth to rock, floods.	Severe: wetness, floods.	Poor: wetness, area reclaim.
411, 411B---------- Waukegan	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
411C---------- Waukegan	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
449---------- Crystal Lake	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
452---------- Comstock	Severe: wetness.	Severe: wetness.	Severe: wetness, too sandy.	Severe: wetness.	Poor: wetness.
453B---------- Demontreville	Severe: percs slowly.	Moderate: slope.	Slight----------	Severe: seepage.	Good.
453C---------- Demontreville	Severe: percs slowly.	Severe: slope.	Slight----------	Severe: seepage.	Fair: slope.
453D---------- Demontreville	Severe: slope, percs slowly.	Severe: slope.	Moderate: slope.	Severe: slope, seepage.	Poor: slope.
454B---------- Mahtomedi	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
454C---------- Mahtomedi	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
454D---------- Mahtomedi	Severe: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage, slope.	Poor: too sandy, slope, seepage.
454F---------- Mahtomedi	Severe: slope.	Severe: seepage, slope.	Severe: slope, seepage, too sandy.	Severe: seepage, slope.	Poor: too sandy, slope, seepage.
456---------- Barronett	Severe: wetness, floods, percs slowly.	Severe: wetness.	Severe: wetness, floods, too sandy.	Severe: wetness, floods.	Poor: wetness.
460B---------- Baytown	Severe: depth to rock.	Severe: seepage, depth to rock.	Severe: seepage, depth to rock.	Severe: seepage.	Poor: area reclaim.
460C---------- Baytown	Severe: depth to rock.	Severe: seepage, slope, depth to rock.	Severe: seepage, depth to rock.	Severe: seepage.	Poor: area reclaim.
468---------- Otter	Severe: wetness, floods.	Severe: floods, wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
472B---------- Channahon	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
472C---------- Channahon	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
472D---------- Channahon	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: slope, depth to rock.	Poor: slope, area reclaim.
481---------- Kratka	Severe: floods, wetness, percs slowly.	Severe: floods, wetness, seepage.	Severe: floods, wetness.	Severe: floods, wetness, seepage.	Poor: wetness.
488F---------- Brodale	Severe: slope, depth to rock.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Poor: slope, small stones.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
504B---------- Duluth	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
504C---------- Duluth	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: slope, too clayey.
504D---------- Duluth	Severe: slope, percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Severe: slope.	Poor: slope.
507---------- Poskin	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage.	Severe: wetness, seepage.	Poor: too sandy, small stones, seepage.
529, 529B---------- Ripon	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.
529C---------- Ripon	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Moderate: slope, depth to rock.	Poor: area reclaim.
540---------- Seelyeville	Severe: wetness, floods, percs slowly.	Severe: floods, seepage, wetness.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: wetness, excess humus.
541---------- Rifle	Severe: floods, wetness.	Severe: excess humus, seepage, wetness.	Severe: wetness, seepage, floods.	Severe: floods, wetness, seepage.	Poor: excess humus, wetness.
543---------- Markey	Severe: floods, wetness, subsides.	Severe: seepage, wetness, excess humus.	Severe: floods, seepage, wetness.	Severe: floods, seepage, wetness.	Poor: excess humus, wetness.
544---------- Cathro	Severe: wetness, floods, percs slowly.	Severe: wetness, excess humus, seepage.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, seepage.	Poor: excess humus, wetness.
552---------- Kerston	Severe: floods, wetness.	Severe: wetness, excess humus, seepage.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Poor: wetness, excess humus.
852B*: Urban land.					
Copaston----------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim.
857*: Urban land.					
Waukegan----------	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
857C*: Urban land.					
Waukegan----------	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
858*: Urban land.					
Chetek	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: small stones.
858C*: Urban land.					
Chetek	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: small stones, slope.
859B*: Urban land.					
Zimmerman	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
860C*: Urban land.					
Hayden	Moderate: percs slowly, slope.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
Kingsley	Severe: percs slowly.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
860D*: Urban land.					
Hayden	Severe: slope.	Severe: slope.	Moderate: slope, too clayey.	Severe: slope.	Poor: slope.
Kingsley	Severe: slope, percs slowly.	Severe: slope.	Moderate: slope.	Severe: slope.	Poor: slope.
861C*: Urban land.					
Kingsley	Severe: percs slowly.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
861D*: Urban land.					
Kingsley	Severe: slope, percs slowly.	Severe: slope.	Moderate: slope.	Severe: slope.	Poor: slope.
862*: Urban land.					
Dundas	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
863*: Urban land.					
Lino	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, too sandy, wetness.	Severe: seepage, wetness.	Poor: too sandy, seepage.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
896C*:					
Mahtomedi	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
Kingsley	Severe: percs slowly.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
896D*:					
Mahtomedi	Severe: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage, slope.	Poor: too sandy, slope, seepage.
Kingsley	Severe: slope, percs slowly.	Severe: slope.	Moderate: slope.	Severe: slope.	Poor: slope.
896F*:					
Mahtomedi	Severe: slope.	Severe: seepage, slope.	Severe: slope, seepage, too sandy.	Severe: seepage, slope.	Poor: too sandy, slope, seepage.
Kingsley	Severe: slope, percs slowly.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
1013*. Pits, quarry					
1027*. Udorthents					
1029*. Pits, gravel					
1033*. Udifluvents					
1039*. Urban land					
1040*. Udorthents					
1055*. Aquolls and Histosols					
1813B--Lino Variant	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
1819F*:					
Dorerton	Severe: slope, large stones.	Severe: seepage, slope, large stones.	Severe: depth to rock, seepage, slope.	Severe: seepage, slope.	Poor: seepage, small stones, slope.
Rock outcrop.					
1820F*:					
Mahtomedi Variant	Severe: slope.	Severe: slope, seepage.	Severe: slope, seepage, depth to rock.	Severe: slope, seepage.	Poor: slope, too sandy, seepage.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1820F*: Rock outcrop.					
1821---------- Algansee	Severe: wetness, floods.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: wetness, too sandy, seepage.
1827, 1827B---------- Waukegan Variant	Severe: depth to rock.	Severe: depth to rock, seepage.	Severe: seepage, depth to rock, too sandy.	Severe: seepage.	Poor: too sandy, area reclaim, seepage.
1847---------- Barronett, sandy substratum	Severe: wetness, floods, percs slowly.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: wetness.
1848B---------- Sparta, bedrock substratum	Moderate: depth to rock.	Severe: seepage.	Severe: depth to rock, too sandy, seepage.	Severe: seepage.	Poor: seepage, too sandy.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
2, 2B Ostrander	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
2C Ostrander	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope.
7B Hubbard	Good	Good	Unsuited: excess fines.	Fair: too sandy.
7C Hubbard	Good	Good	Unsuited: excess fines.	Fair: too sandy, slope.
7D Hubbard	Fair: slope.	Good	Unsuited: excess fines.	Poor: slope.
8, 8B Sparta	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy.
8C Sparta	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy, slope.
12C Emmert	Good	Good	Good	Poor: small stones, thin layer.
12D Emmert	Fair: slope.	Good	Good	Poor: small stones, thin layer, slope.
49, 49B Antigo	Good	Good	Good	Fair: area reclaim.
49C Antigo	Good	Good	Good	Fair: slope, area reclaim.
49D Antigo	Fair: slope.	Good	Good	Poor: slope.
75 Bluffton	Poor: wetness, low strength.	Poor: excess fines.	Unsuited: excess fines.	Poor: wetness.
100B, 100C Copaston	Poor: thin layer, area reclaim.	Unsuited: thin layer.	Unsuited: excess fines.	Poor: area reclaim.
113 Webster	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
120 Brill	Fair: wetness.	Good	Good	Fair: thin layer.
123 Dundas	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
132B Hayden	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
132C---------- Hayden	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, thin layer.
132D---------- Hayden	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
151, 151B---------- Burkhardt	Good----------	Good----------	Good----------	Good.
153B---------- Santiago	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Good.
153C---------- Santiago	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Fair: slope.
155B---------- Chetek	Good----------	Good----------	Unsuited: excess fines.	Good.
155C---------- Chetek	Good----------	Good----------	Unsuited: excess fines.	Fair: slope.
155D---------- Chetek	Fair: slope.	Good----------	Unsuited: excess fines.	Poor: slope.
158B---------- Zimmerman	Good----------	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy.
158C---------- Zimmerman	Good----------	Fair: excess fines.	Unsuited: excess fines.	Fair: slope, too sandy.
158D---------- Zimmerman	Fair: slope.	Fair: excess fines.	Unsuited: excess fines.	Poor: slope.
159, 159B---------- Anoka	Fair: low strength.	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy.
161---------- Isanti	Poor: wetness.	Fair: excess fines.	Unsuited: excess fines.	Poor: wetness.
162---------- Lino	Fair: wetness.	Good----------	Unsuited: excess fines.	Poor: too sandy.
166---------- Ronneby	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Good.
169B---------- Braham	Fair: low strength.	Poor: thin layer.	Unsuited: excess fines.	Fair: too sandy.
169C---------- Braham	Fair: low strength.	Poor: thin layer.	Unsuited: excess fines.	Fair: too sandy, slope.
170---------- Blomford	Poor: wetness.	Poor: thin layer.	Unsuited: excess fines.	Poor: wetness.
174C---------- Gale	Poor: area reclaim, thin layer.	Poor: thin layer.	Unsuited: excess fines.	Fair: slope, area reclaim, thin layer.
174F---------- Gale	Poor: area reclaim, slope, thin layer.	Poor: thin layer.	Unsuited: excess fines.	Poor: slope.
177B---------- Gotham	Good----------	Good----------	Unsuited: excess fines.	Fair: too sandy.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
177C---------- Gotham	Good----------	Good----------	Unsuited: excess fines.	Fair: slope, too sandy.
177D---------- Gotham	Fair: slope.	Good----------	Unsuited: excess fines.	Poor: slope.
189---------- Auburndale	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Poor: wetness.
225---------- Nessel	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
259B---------- Grays	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
264---------- Freeon	Fair: low strength, wetness.	Poor: excess fines.	Unsuited: excess fines.	Good.
265---------- Soderville	Fair: wetness.	Good----------	Unsuited: excess fines.	Fair: too sandy.
266---------- Freer	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Good.
298, 298B---------- Richwood	Fair: low strength, thin layer, shrink-swell.	Fair: excess fines.	Unsuited: excess fines.	Good.
301B---------- Lindstrom	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
302B, 302C---------- Rosholt	Good----------	Good----------	Good----------	Poor: small stones.
325---------- Prebish	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Poor: wetness.
327, 327B---------- Dickman	Good----------	Fair: excess fines.	Unsuited: excess fines.	Good.
327C---------- Dickman	Good----------	Fair: excess fines.	Unsuited: excess fines.	Fair: slope.
329---------- Chaska	Poor: wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
340B---------- Whalan	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, area reclaim.
340C---------- Whalan	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, thin layer, area reclaim.
342B---------- Kingsley	Good----------	Poor: excess fines.	Unsuited: excess fines.	Fair: small stones.
342C---------- Kingsley	Good----------	Poor: excess fines.	Unsuited: excess fines.	Fair: slope, small stones.
342D, 342E---------- Kingsley	Fair: slope.	Poor: excess fines.	Unsuited: excess fines.	Poor: slope.
367B---------- Campia	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
408---------- Faxon	Poor: wetness, low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
411, 411B---------- Waukegan	Good----------	Good----------	Unsuited: excess fines.	Good.
411C---------- Waukegan	Good----------	Good----------	Unsuited: excess fines.	Fair: slope.
449---------- Crystal Lake	Fair: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
452---------- Comstock	Poor: wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
453B---------- Demontreville	Fair: low strength.	Poor: thin layer.	Unsuited: excess fines.	Fair: too sandy.
453C---------- Demontreville	Fair: low strength.	Poor: thin layer.	Unsuited: excess fines.	Fair: too sandy, slope.
453D---------- Demontreville	Fair: slope, low strength.	Poor: thin layer.	Unsuited: excess fines.	Poor: slope.
454B---------- Mahtomedi	Good----------	Good----------	Unsuited: excess fines.	Fair: too sandy.
454C---------- Mahtomedi	Good----------	Good----------	Unsuited: excess fines.	Fair: too sandy, slope.
454D---------- Mahtomedi	Fair: slope.	Good----------	Unsuited: excess fines.	Poor: slope.
454F---------- Mahtomedi	Poor: slope.	Good----------	Unsuited: excess fines.	Poor: slope.
456---------- Barronett	Poor: wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
460B---------- Baytown	Poor: thin layer, area reclaim.	Poor: thin layer.	Unsuited: excess fines.	Fair: area reclaim.
460C---------- Baytown	Poor: thin layer, area reclaim.	Poor: thin layer.	Unsuited: excess fines.	Fair: slope, area reclaim.
468---------- Otter	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
472B, 472C---------- Channahon	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: area reclaim.
472D---------- Channahon	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope, area reclaim.
481---------- Kratka	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Poor: wetness.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
488F---------- Brodale	Poor: slope.	Poor: excess fines.	Poor: excess fines.	Poor: large stones, slope.
504B---------- Duluth	Poor: low strength.	Poor: excess fines.	Unsuited: excess fines.	Fair: small stones.
504C---------- Duluth	Poor: low strength.	Poor: excess fines.	Unsuited: excess fines.	Fair: slope, small stones.
504D---------- Duluth	Poor: low strength.	Poor: excess fines.	Unsuited: excess fines.	Poor: slope.
507---------- Poskin	Fair: wetness.	Good----------	Good----------	Fair: thin layer.
529, 529B---------- Ripon	Poor: area reclaim, thin layer, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim, thin layer.
529C---------- Ripon	Poor: area reclaim, thin layer, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, area reclaim, thin layer.
540---------- Seelyeville	Poor: low strength, wetness.	Unsuited: excess humus.	Unsuited: excess humus.	Poor: wetness, excess humus.
541---------- Rifle	Poor: low strength, wetness.	Unsuited: excess humus.	Unsuited: excess humus.	Poor: wetness, excess humus.
543---------- Markey	Poor: low strength, wetness.	Good----------	Unsuited: excess fines, excess humus.	Poor: excess humus, wetness.
544---------- Cathro	Poor: excess humus, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness, excess humus.
552---------- Kerston	Poor: low strength, wetness.	Unsuited: excess humus.	Unsuited: excess humus.	Poor: wetness, excess humus.
852B*: Urban land.				
Copaston----------	Poor: thin layer, area reclaim.	Unsuited: thin layer.	Unsuited: excess fines.	Poor: area reclaim.
857*: Urban land.				
Waukegan----------	Good----------	Good----------	Unsuited: excess fines.	Good.
857C*: Urban land.				
Waukegan----------	Good----------	Good----------	Unsuited: excess fines.	Fair: slope.
858*: Urban land.				

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
858*:				
Chetek	Good	Good	Unsuited: excess fines.	Good.
858C*:				
Urban land.				
Chetek	Good	Good	Unsuited: excess fines.	Fair: slope.
859B*:				
Urban land.				
Zimmerman	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy.
860C*:				
Urban land.				
Hayden	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, thin layer.
Kingsley	Good	Poor: excess fines.	Unsuited: excess fines.	Fair: slope, small stones.
860D*:				
Urban land.				
Hayden	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
Kingsley	Fair: slope.	Poor: excess fines.	Unsuited: excess fines.	Poor: slope.
861C*:				
Urban land.				
Kingsley	Good	Poor: excess fines.	Unsuited: excess fines.	Fair: slope, small stones.
861D*:				
Urban land.				
Kingsley	Fair: slope.	Poor: excess fines.	Unsuited: excess fines.	Poor: slope.
862*:				
Urban land.				
Dundas	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
863*:				
Urban land.				
Lino	Fair: wetness.	Good	Unsuited: excess fines.	Poor: too sandy.
896C*:				
Mahtomedi	Good	Good	Unsuited: excess fines.	Fair: too sandy, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
896C*:				
Kingsley	Good	Poor: excess fines.	Unsuited: excess fines.	Fair: slope, small stones.
896D*:				
Mahtomedi	Fair: slope.	Good	Unsuited: excess fines.	Poor: slope.
Kingsley	Fair: slope.	Poor: excess fines.	Unsuited: excess fines.	Poor: slope.
896F*:				
Mahtomedi	Poor: slope.	Good	Unsuited: excess fines.	Poor: slope.
Kingsley	Poor: slope.	Poor: excess fines.	Unsuited: excess fines.	Poor: slope.
1013*. Pits, quarry				
1027*. Udorthents				
1029*. Pits, gravel				
1033*. Udifluvents				
1039*. Urban land				
1040*. Udorthents				
1055*. Aquolls and Histosols				
1813B Lino Variant	Good	Fair: excess fines.	Unsuited: excess fines.	Poor: thin layer.
1819F*:				
Dorerton	Poor: slope.	Poor: excess fines, large stones.	Poor: excess fines, large stones.	Poor: slope, area reclaim.
Rock outcrop.				
1820F*:				
Mahtomedi Variant	Poor: slope.	Poor: thin layer.	Unsuited: excess fines.	Poor: slope.
Rock outcrop.				
1821 Algansee	Poor: wetness.	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy.
1827, 1827B Waukegan Variant	Poor: thin layer, area reclaim.	Poor: thin layer.	Unsuited: excess fines.	Fair: area reclaim.
1847 Barronett, sandy substratum	Poor: wetness.	Good	Unsuited: excess fines.	Poor: wetness.
1848B Sparta, bedrock substratum	Poor: thin layer.	Poor: thin layer.	Unsuited: excess fines.	Poor: too sandy.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
2---- Ostrander	Seepage	Favorable	Not needed	Favorable	Not needed	Erodes easily.
2B---- Ostrander	Seepage	Favorable	Not needed	Favorable	Favorable	Erodes easily.
2C---- Ostrander	Slope, seepage.	Favorable	Not needed	Slope	Favorable	Slope, erodes easily.
7B---- Hubbard	Seepage	Seepage	Not needed	Fast intake, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
7C---- Hubbard	Slope, seepage.	Seepage	Not needed	Fast intake, droughty, soil blowing.	Too sandy, soil blowing.	Slope, droughty.
7D---- Hubbard	Slope, seepage.	Seepage	Not needed	Fast intake, droughty, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
8---- Sparta	Seepage	Piping, seepage.	Not needed	Fast intake, droughty, soil blowing.	Not needed	Droughty.
8B---- Sparta	Seepage	Piping, seepage.	Not needed	Fast intake, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
8C---- Sparta	Slope, seepage.	Piping, seepage.	Not needed	Fast intake, droughty, soil blowing.	Too sandy, soil blowing.	Slope, droughty.
12C---- Emmert	Slope, seepage.	Seepage	Not needed	Droughty, fast intake, slope.	Too sandy	Slope, droughty.
12D---- Emmert	Slope, seepage.	Seepage	Not needed	Droughty, fast intake, slope.	Slope, too sandy.	Slope, droughty.
49---- Antigo	Seepage	Seepage	Not needed	Erodes easily	Not needed	Erodes easily.
49B---- Antigo	Seepage	Seepage	Not needed	Erodes easily	Too sandy	Erodes easily.
49C---- Antigo	Seepage, slope.	Seepage	Not needed	Slope, erodes easily.	Too sandy	Slope, erodes easily.
49D---- Antigo	Seepage, slope.	Seepage	Not needed	Slope, erodes easily.	Too sandy, slope.	Slope, erodes easily.
75---- Bluffton	Favorable	Piping, wetness.	Floods, frost action.	Wetness, floods.	Not needed	Wetness.
100B---- Copaston	Depth to rock	Thin layer	Not needed	Droughty, rooting depth.	Depth to rock	Rooting depth, droughty.
100C---- Copaston	Slope, depth to rock.	Thin layer	Not needed	Droughty, rooting depth, slope.	Depth to rock	Droughty, slope, rooting depth.
113---- Webster	Seepage	Wetness	Frost action	Wetness	Not needed	Wetness.
120---- Brill	Seepage	Seepage	Not needed	Favorable	Not needed	Erodes easily.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
123---------- Dundas	Seepage--------	Wetness, hard to pack.	Frost action---	Wetness, soil blowing.	Not needed-----	Wetness.
132B---------- Hayden	Seepage--------	Favorable------	Not needed-----	Soil blowing---	Soil blowing---	Favorable.
132C---------- Hayden	Slope, seepage.	Favorable------	Not needed-----	Slope, soil blowing.	Soil blowing---	Slope.
132D---------- Hayden	Slope, seepage.	Favorable------	Not needed-----	Slope, soil blowing.	Slope, soil blowing.	Slope.
151---------- Burkhardt	Seepage--------	Seepage--------	Not needed-----	Droughty, soil blowing.	Not needed-----	Droughty.
151B---------- Burkhardt	Slope, seepage.	Seepage--------	Not needed-----	Droughty, soil blowing, slope.	Soil blowing, too sandy.	Droughty.
153B---------- Santiago	Seepage--------	Piping---------	Not needed-----	Erodes easily	Favorable------	Erodes easily.
153C---------- Santiago	Slope, seepage.	Piping---------	Not needed-----	Slope, erodes easily.	Favorable------	Slope, erodes easily.
155B---------- Chetek	Seepage--------	Seepage--------	Not needed-----	Droughty, soil blowing.	Soil blowing, too sandy.	Droughty.
155C---------- Chetek	Slope, seepage.	Seepage--------	Not needed-----	Droughty, soil blowing, slope.	Soil blowing, too sandy.	Droughty, slope.
155D---------- Chetek	Slope, seepage.	Seepage--------	Not needed-----	Droughty, soil blowing, slope.	Slope, soil blowing, too sandy.	Droughty, slope.
158B---------- Zimmerman	Seepage--------	Piping, seepage.	Not needed-----	Droughty, soil blowing, fast intake.	Too sandy, soil blowing.	Droughty.
158C---------- Zimmerman	Seepage, slope.	Piping, seepage.	Not needed-----	Droughty, soil blowing, fast intake.	Too sandy, soil blowing.	Slope, droughty.
158D---------- Zimmerman	Seepage, slope.	Piping, seepage.	Not needed-----	Droughty, soil blowing, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
159---------- Anoka	Seepage--------	Piping---------	Not needed-----	Fast intake, soil blowing.	Soil blowing, too sandy.	Favorable.
159B---------- Anoka	Seepage, slope.	Piping---------	Not needed-----	Fast intake, soil blowing, slope.	Soil blowing, too sandy.	Favorable.
161---------- Isanti	Seepage--------	Seepage, wetness.	Favorable------	Wetness, droughty, fast intake.	Not needed-----	Wetness, droughty.
162---------- Lino	Seepage--------	Piping, seepage, wetness.	Favorable------	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
166---------- Ronneby	Seepage--------	Wetness--------	Frost action---	Wetness, soil blowing, rooting depth.	Not needed-----	Rooting depth.
169B---------- Braham	Seepage--------	Piping---------	Not needed-----	Soil blowing, fast intake.	Too sandy, soil blowing.	Favorable.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
169C---------- Braham	Slope, seepage.	Piping---------	Not needed-----	Slope, soil blowing, fast intake.	Too sandy, soil blowing.	Slope.
170---------- Blomford	Seepage--------	Wetness, piping.	Favorable------	Wetness, fast intake, soil blowing.	Not needed-----	Wetness, erodes easily.
174C---------- Gale	Slope, seepage, depth to rock.	Thin layer-----	Not needed-----	Slope, erodes easily, rooting depth.	Too sandy, depth to rock.	Slope, depth to rock, erodes easily.
174F---------- Gale	Slope, seepage, depth to rock.	Thin layer-----	Not needed-----	Slope, erodes easily, rooting depth.	Slope, too sandy, depth to rock.	Slope, depth to rock, erodes easily.
177B---------- Gotham	Seepage--------	Seepage, piping.	Not needed-----	Fast intake, soil blowing.	Too sandy, soil blowing.	Favorable.
177C---------- Gotham	Slope, seepage.	Seepage, piping.	Not needed-----	Slope, fast intake, soil blowing.	Too sandy, soil blowing.	Slope.
177D---------- Gotham	Slope, seepage.	Seepage, piping.	Not needed-----	Slope, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope.
189---------- Auburndale	Seepage--------	Wetness--------	Floods, frost action.	Wetness, floods, erodes easily.	Not needed-----	Erodes easily, wetness.
225---------- Nessel	Seepage--------	Favorable------	Not needed-----	Soil blowing---	Soil blowing---	Favorable.
259B---------- Grays	Seepage--------	Piping---------	Not needed-----	Favorable------	Erodes easily	Erodes easily.
264---------- Freeon	Seepage--------	Wetness, seepage.	Favorable------	Wetness, erodes easily.	Wetness--------	Erodes easily.
265---------- Soderville	Seepage--------	Piping, seepage, wetness.	Favorable------	Fast intake, wetness, soil blowing.	Wetness, too sandy.	Favorable.
266---------- Freer	Favorable------	Wetness--------	Frost action---	Wetness--------	Not needed-----	Erodes easily, wetness.
298---------- Richwood	Seepage--------	Thin layer-----	Not needed-----	Favorable------	Not needed-----	Erodes easily.
298B---------- Richwood	Seepage--------	Thin layer-----	Not needed-----	Favorable------	Erodes easily, too sandy.	Erodes easily.
301B---------- Lindstrom	Seepage--------	Piping---------	Not needed-----	Favorable------	Erodes easily	Erodes easily.
302B---------- Rosholt	Seepage--------	Seepage--------	Not needed-----	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
302C---------- Rosholt	Seepage, slope.	Seepage--------	Not needed-----	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Slope, droughty.
325---------- Prebish	Favorable------	Wetness--------	Frost action, floods.	Wetness, floods.	Not needed-----	Wetness.
327---------- Dickman	Seepage--------	Seepage--------	Not needed-----	Droughty, soil blowing.	Not needed-----	Droughty.
327B---------- Dickman	Seepage--------	Seepage--------	Not needed-----	Droughty, soil blowing.	Too sandy------	Droughty.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
327C---------- Dickman	Seepage, slope.	Seepage--------	Not needed-----	Slope, droughty, soil blowing.	Too sandy------	Droughty, slope.
329---------- Chaska	Seepage--------	Wetness, piping.	Floods, frost action.	Wetness, floods.	Not needed-----	Wetness.
340B---------- Whalan	Depth to rock	Thin layer-----	Not needed-----	Rooting depth	Depth to rock	Depth to rock.
340C---------- Whalan	Slope, depth to rock.	Thin layer-----	Not needed-----	Slope, rooting depth.	Depth to rock	Slope, depth to rock.
342B---------- Kingsley	Favorable------	Seepage--------	Not needed-----	Soil blowing---	Soil blowing---	Favorable.
342C---------- Kingsley	Slope----------	Seepage--------	Not needed-----	Soil blowing, slope.	Soil blowing---	Slope.
342D, 342E-------- Kingsley	Slope----------	Seepage--------	Not needed-----	Soil blowing, slope.	Slope, soil blowing.	Slope.
367B---------- Campia	Seepage--------	Piping---------	Not needed-----	Erodes easily	Favorable------	Erodes easily.
408---------- Faxon	Depth to rock	Thin layer, wetness.	Depth to rock, frost action, floods.	Wetness, rooting depth, floods.	Not needed-----	Wetness, depth to rock.
411, 411B--------- Waukegan	Seepage--------	Seepage--------	Not needed-----	Favorable------	Erodes easily, too sandy.	Erodes easily.
411C---------- Waukegan	Slope, seepage.	Seepage--------	Not needed-----	Slope----------	Erodes easily, too sandy.	Erodes easily, slope.
449---------- Crystal Lake	Seepage--------	Wetness--------	Not needed-----	Erodes easily	Favorable------	Erodes easily.
452---------- Comstock	Seepage--------	Wetness--------	Frost action---	Wetness, erodes easily.	Not needed-----	Wetness, erodes easily.
453B---------- Demontreville	Seepage--------	Favorable------	Not needed-----	Fast intake, soil blowing.	Too sandy, soil blowing.	Favorable.
453C---------- Demontreville	Slope, seepage.	Favorable------	Not needed-----	Slope, fast intake, soil blowing.	Too sandy, soil blowing.	Slope.
453D---------- Demontreville	Slope, seepage.	Favorable------	Not needed-----	Slope, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope.
454B---------- Mahtomedi	Seepage--------	Seepage--------	Not needed-----	Soil blowing, fast intake, droughty.	Too sandy, soil blowing.	Droughty.
454C---------- Mahtomedi	Seepage, slope.	Seepage--------	Not needed-----	Soil blowing, fast intake, droughty.	Too sandy, soil blowing.	Slope, droughty.
454D, 454F-------- Mahtomedi	Seepage, slope.	Seepage--------	Not needed-----	Soil blowing, fast intake, droughty.	Slope, too sandy, soil blowing.	Slope, droughty.
456---------- Barronett	Seepage--------	Wetness--------	Floods, frost action.	Floods, wetness, erodes easily.	Not needed-----	Wetness, erodes easily.
460B---------- Baytown	Seepage--------	Piping---------	Not needed-----	Rooting depth	Depth to rock	Depth to rock.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
460C---------- Baytown	Seepage, slope.	Piping---------	Not needed-----	Slope, rooting depth.	Depth to rock	Slope, depth to rock.
468---------- Otter	Seepage---------	Wetness---------	Floods, frost action.	Wetness, floods.	Not needed-----	Wetness.
472B---------- Channahon	Depth to rock	Thin layer-----	Not needed-----	Rooting depth, erodes easily.	Depth to rock	Erodes easily, rooting depth.
472C---------- Channahon	Depth to rock, slope.	Thin layer-----	Not needed-----	Rooting depth, slope, erodes easily.	Depth to rock	Slope, erodes easily, rooting depth.
472D---------- Channahon	Depth to rock, slope.	Thin layer-----	Not needed-----	Rooting depth, slope, erodes easily.	Depth to rock, slope.	Slope, erodes easily, rooting depth.
481---------- Kratka	Seepage---------	Piping, wetness.	Frost action---	Wetness, soil blowing.	Not needed-----	Wetness.
488F---------- Brodale	Seepage, slope, depth to rock.	Large stones, piping.	Not needed-----	Slope, droughty, rooting depth.	Slope, large stones.	Slope, large stones, droughty.
504B---------- Duluth	Favorable------	Piping---------	Not needed-----	Percs slowly, erodes easily.	Percs slowly---	Erodes easily, percs slowly.
504C---------- Duluth	Slope----------	Piping---------	Not needed-----	Percs slowly, erodes easily, slope.	Percs slowly---	Erodes easily, slope, percs slowly.
504D---------- Duluth	Slope----------	Piping---------	Not needed-----	Percs slowly, erodes easily, slope.	Slope, percs slowly.	Erodes easily, slope, percs slowly.
507---------- Poskin	Seepage---------	Seepage, wetness.	Frost action---	Wetness, erodes easily.	Not needed-----	Erodes easily, wetness.
529---------- Ripon	Depth to rock, seepage.	Thin layer, piping.	Not needed-----	Rooting depth	Not needed-----	Depth to rock.
529B---------- Ripon	Depth to rock, seepage.	Thin layer, piping.	Not needed-----	Rooting depth	Depth to rock	Depth to rock.
529C---------- Ripon	Slope, depth to rock, seepage.	Thin layer, piping.	Not needed-----	Slope, rooting depth.	Depth to rock	Slope, depth to rock.
540---------- Seelyeville	Seepage---------	Excess humus, wetness.	Floods, frost action, excess humus.	Wetness, floods, soil blowing.	Not needed-----	Wetness.
541---------- Rifle	Seepage---------	Excess humus, wetness.	Frost action, excess humus, floods.	Soil blowing, wetness, floods.	Not needed-----	Wetness.
543---------- Markey	Seepage---------	Seepage, wetness, excess humus.	Floods, excess humus, frost action.	Wetness, soil blowing, floods.	Not needed-----	Wetness.
544---------- Cathro	Seepage---------	Piping, wetness.	Floods, frost action.	Wetness, soil blowing, floods.	Not needed-----	Wetness.
552---------- Kerston	Seepage---------	Excess humus, wetness.	Floods, excess humus, frost action.	Soil blowing, wetness, floods.	Not needed-----	Wetness.
852B*: Urban land.						

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
852B*:						
Copaston	Depth to rock	Thin layer	Not needed	Droughty, rooting depth.	Depth to rock	Rooting depth, droughty.
857*:						
Urban land.						
Waukegan	Seepage	Seepage	Not needed	Favorable	Erodes easily, too sandy.	Erodes easily.
857C*:						
Urban land.						
Waukegan	Slope, seepage.	Seepage	Not needed	Slope	Erodes easily, too sandy.	Erodes easily, slope.
858*:						
Urban land.						
Chetek	Seepage	Seepage	Not needed	Droughty, soil blowing.	Not needed	Droughty.
858C*:						
Urban land.						
Chetek	Slope, seepage.	Seepage	Not needed	Droughty, soil blowing, slope.	Soil blowing, too sandy.	Droughty, slope.
859B*:						
Urban land.						
Zimmerman	Seepage	Piping, seepage.	Not needed	Droughty, soil blowing, fast intake.	Too sandy, soil blowing.	Droughty.
860C*:						
Urban land.						
Hayden	Slope, seepage.	Favorable	Not needed	Slope, soil blowing.	Soil blowing	Slope.
Kingsley	Slope	Seepage	Not needed	Soil blowing, slope.	Soil blowing	Slope.
860D*:						
Urban land.						
Hayden	Slope, seepage.	Favorable	Not needed	Slope, soil blowing.	Slope, soil blowing.	Slope.
Kingsley	Slope	Seepage	Not needed	Soil blowing, slope.	Slope, soil blowing.	Slope.
861C*:						
Urban land.						
Kingsley	Slope	Seepage	Not needed	Soil blowing, slope.	Soil blowing	Slope.
861D*:						
Urban land.						
Kingsley	Slope	Seepage	Not needed	Soil blowing, slope.	Slope, soil blowing.	Slope.
862*:						
Urban land.						

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
862*: Dundas	Seepage	Wetness, hard to pack.	Frost action	Wetness, soil blowing.	Not needed	Wetness.
863*: Urban land.						
Lino	Seepage	Piping, seepage, wetness.	Favorable	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
896C*: Mahtomedi	Seepage, slope.	Seepage	Not needed	Soil blowing, fast intake, droughty.	Too sandy, soil blowing.	Slope, droughty.
Kingsley	Slope	Seepage	Not needed	Soil blowing, slope.	Soil blowing	Slope.
896D*, 896F*: Mahtomedi	Seepage, slope.	Seepage	Not needed	Soil blowing, fast intake, droughty.	Slope, too sandy, soil blowing.	Slope, droughty.
Kingsley	Slope	Seepage	Not needed	Soil blowing, slope.	Slope, soil blowing.	Slope.
1013*. Pits, quarry						
1027*. Udorthents						
1029*. Pits, gravel						
1033*. Udifluvents						
1039*. Urban land						
1040*. Udorthents						
1055*. Aquolls and Histosols						
1813B Lino Variant	Seepage	Seepage	Not needed	Fast intake, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
1819F*: Dorerton	Seepage, slope.	Seepage, large stones.	Not needed	Large stones, slope.	Large stones, slope.	Large stones, slope.
Rock outcrop.						
1820F*: Mahtomedi Variant	Slope, seepage.	Piping, seepage.	Not needed	Slope, droughty, soil blowing.	Slope, too sandy, soil blowing.	Droughty, slope.
Rock outcrop.						
1821 Algansee	Seepage	Seepage	Floods	Wetness, droughty, fast intake.	Not needed	Wetness, droughty.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
1827---------- Waukegan Variant	Depth to rock, seepage.	Thin layer, seepage, piping.	Not needed-----	Rooting depth	Not needed-----	Depth to rock.
1827B---------- Waukegan Variant	Depth to rock, seepage.	Thin layer, seepage, piping.	Not needed-----	Rooting depth	Too sandy------	Depth to rock.
1847---------- Barronett, sandy substratum	Seepage--------	Wetness--------	Floods, frost action.	Wetness, floods.	Not needed-----	Wetness.
1848B---------- Sparta, bedrock substratum	Seepage--------	Seepage, piping.	Not needed-----	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
2, 2B, 2C----------	0-30	Silt loam, loam	CL-ML, CL	A-4, A-6	0	100	98-100	90-95	70-90	25-40	5-15
Ostrander	30-36	Loam, silt loam	CL, CL-ML	A-4	0-1	95-100	98-100	90-95	70-90	25-40	5-15
	36-60	Loam, clay loam, sandy loam.	CL, SC	A-6	0-2	95-100	75-98	65-90	45-75	25-35	10-15
7B, 7C, 7D---------	0-20	Loamy sand------	SM, SP-SM	A-2	0	98-100	95-100	50-80	10-25	<20	NP
Hubbard	20-35	Sand, coarse sand, loamy sand.	SP-SM, SW-SM	A-1, A-3, A-2-4	0	98-100	70-100	25-75	5-12	<20	NP
	35-60	Sand, coarse sand.	SP, SW	A-1, A-3, A-2-4	0	95-100	70-100	20-70	2-5	<20	NP
8, 8B, 8C----------	0-28	Loamy sand------	SM, ML	A-2, A-4	0	100	100	60-95	20-55	---	NP
Sparta	28-60	Loamy fine sand, fine sand, sand.	SP-SM, SM	A-2, A-3, A-4	0	100	100	60-95	5-50	---	NP
12C, 12D----------	0-6	Gravelly loamy coarse sand.	SM, SP-SM	A-1	0-10	80-90	65-75	30-50	10-20	<25	NP-4
Emmert	6-60	Gravelly coarse sand.	GW, GP, SP, SW	A-1	0-10	35-60	25-45	10-25	0-5	---	NP
49, 49B, 49C, 49D--	0-8	Silt loam-------	ML, CL, CL-ML	A-4	0	100	100	90-100	80-100	20-30	3-10
Antigo	8-13	Silt loam, silt	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	80-100	15-30	2-12
	13-26	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	80-90	70-90	25-45	10-25
	26-38	Loam, gravelly sandy loam, loamy sand.	SM, SM-SC, ML, CL-ML	A-2, A-4	0-6	85-100	80-100	50-85	25-65	<20	2-6
	38-60	Stratified sand to gravel.	SP, SP-SM, GP, GP-GM	A-2, A-3, A-1	0-6	45-90	40-85	25-55	2-10	---	NP
75----------	0-19	Loam----------	CL, SC	A-6, A-7	0	98-100	85-100	85-95	45-80	30-45	10-20
Bluffton	19-22	Fine sandy loam, loam, sandy clay loam.	SM, ML, CL, SC	A-4, A-6	0-3	95-100	85-100	70-90	40-60	20-35	3-18
	22-60	Loam, sandy clay loam, fine sandy loam.	CL, ML, SC, SM	A-6, A-4	0-5	90-100	85-100	70-90	40-65	20-40	3-20
100B, 100C---------	0-8	Loam----------	SM, ML	A-4	0	95-100	90-100	65-80	45-60	30-40	NP-10
Copaston	8-14	Fine sandy loam, sandy loam, loam.	SM	A-2, A-4	0	95-100	70-100	55-75	25-50	<35	NP-10
	14-18	Sandy loam, gravelly sandy loam.	SM	A-2	0-5	90-100	70-100	50-70	20-35	---	NP
	18	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
113----------	0-16	Loam, clay loam	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
Webster	16-25	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	25-60	Loam, sandy clay loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
120---------- Brill	0-11	Silt loam-------	ML, CL, CL-ML	A-4	0	100	100	90-100	70-90	20-30	3-10
	11-14	Silt loam, silt	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	70-100	15-30	2-12
	14-35	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	90-100	80-90	70-90	25-45	10-25
	35-60	Stratified sand to gravel.	SP, SP-SM, GP, GP-GM	A-2, A-3, A-1	0-6	45-90	40-85	25-55	2-10	---	NP
123---------- Dundas	0-9	Fine sandy loam	SM, ML	A-4	0	100	95-98	85-95	40-60	20-30	NP-6
	9-45	Clay loam, silty clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-2	97-100	90-98	85-97	50-90	35-60	15-30
	45-60	Clay loam, loam, fine sandy loam.	CL, SC	A-6	0-2	95-100	90-98	80-95	35-70	30-40	10-20
132B, 132C, 132D--- Hayden	0-15	Fine sandy loam	SM, SM-SC, SC	A-4	0	100	95-100	65-85	35-50	20-30	NP-8
	15-50	Clay loam, loam, sandy loam.	CL	A-7, A-6	0	95-100	90-98	80-95	55-75	30-50	15-26
	50-60	Loam, sandy loam, fine sandy loam.	CL, SC	A-6, A-4	0-5	95-100	90-98	75-90	35-70	20-15	8-15
151, 151B---------- Burkhardt	0-13	Sandy loam------	SM, SM-SC	A-2, A-4	0	95-100	95-100	60-70	25-40	<20	2-7
	13-16	Sandy loam, loam	SM, ML, SC, CL	A-2, A-4	0	95-100	85-100	60-95	25-60	15-30	2-10
	16-60	Sand and gravel, loamy coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0	50-75	45-75	20-35	1-5	---	NP
153B, 153C--------- Santiago	0-10	Silt loam-------	ML, CL, CL-ML	A-4	0	95-100	95-100	90-100	70-100	20-30	3-10
	10-25	Silt loam-------	CL, CL-ML	A-4, A-6	0	95-100	95-100	90-100	70-100	20-30	5-12
	25-60	Sandy loam, loamy sand, fine sandy loam.	SM, SC, SM-SC, SP-SM	A-2, A-4, A-1	0-5	70-90	70-90	35-75	10-50	<30	NP-8
155B---------- Chetek	0-8	Sandy loam------	SM, ML, SM-SC, CL-ML	A-2, A-4	0	95-100	95-100	60-85	25-55	<20	2-7
	8-19	Loam, sandy loam, gravelly sandy loam.	ML, CL-ML, SM, SM-SC	A-2, A-4	0	95-100	95-100	60-95	25-60	15-30	2-10
	19-60	Sand and gravel	SP	A-1	0	85-95	65-75	40-50	1-5	---	NP
155C, 155D--------- Chetek	0-9	Sandy loam------	SM, ML, SM-SC, CL-ML	A-2, A-4	0	95-100	95-100	60-85	25-55	<20	2-7
	9-18	Loam, sandy loam	ML, CL-ML, SM, SM-SC	A-2, A-4	0	95-100	95-100	60-95	25-60	15-30	2-10
	18-60	Sand and gravel	SP	A-1	0	85-95	65-75	40-50	1-5	---	NP
158B, 158C, 158D--- Zimmerman	0-15	Loamy fine sand	SM	A-2	0	100	100	95-100	15-30	<20	NP
	15-60	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	100	95-100	5-20	<20	NP
159, 159B---------- Anoka	0-9	Loamy fine sand	SM	A-2	0	100	100	95-100	20-35	<20	NP
	9-60	Very fine sand, loamy fine sand, fine sand.	SM	A-2, A-4	0	100	100	95-100	20-50	---	NP

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
161---------- Isanti	0-13	Loamy fine sand	SM, SP-SM	A-2, A-3	0	100	100	75-100	5-35	<20	NP
	13-42	Fine sand, sand, loamy fine sand.	SM, SP-SM	A-2	0	100	100	85-100	10-35	<20	NP
	42-60	Fine sand, sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	100	85-100	5-35	<20	NP
162---------- Lino	0-9	Loamy fine sand	SM	A-2	0	100	100	95-100	15-30	<20	NP
	9-36	Fine sand, loamy fine sand.	SM, SP-SM	A-2	0	100	100	95-100	12-25	<20	NP
	36-60	Fine sand, sand	SM, SP-SM, SP	A-2, A-3	0	100	100	90-100	2-20	<20	NP
166---------- Ronneby	0-18	Fine sandy loam	SM	A-4	0-5	95-100	80-100	65-95	35-50	<25	NP-4
	18-41	Fine sandy loam, sandy loam, loam.	SM, ML	A-4	0-5	85-95	70-90	65-85	35-60	<20	NP-4
	41-60	Sandy loam, fine sandy loam.	SM	A-4, A-2	0-5	85-95	70-90	60-80	25-50	<20	NP-4
169B, 169C--------- Braham	0-9	Loamy fine sand	SM	A-2	0	100	100	55-70	20-35	---	NP
	9-28	Loamy fine sand, loamy sand, fine sand.	SP-SM, SM	A-2	0	100	100	65-90	10-20	---	NP
	28-60	Sandy clay loam, loam, fine sandy loam.	CL, ML, SC, SM	A-4, A-6	3-8	95-100	85-100	75-90	40-75	20-40	3-15
170---------- Blomford	0-9	Loamy fine sand	SM	A-2	0	100	100	70-80	20-35	<20	NP
	9-25	Loamy fine sand, loamy sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	100	65-80	5-20	<20	NP
	25-39	Sandy clay loam, fine sandy loam, clay loam.	ML, CL, SC, SM	A-6, A-4, A-7	0-8	95-100	85-100	80-95	40-85	30-45	6-20
	39-60	Loam, sandy clay loam, fine sandy loam.	ML, CL, SC, SM	A-4, A-6	0-5	95-100	85-100	80-95	40-80	25-40	3-15
174C, 174F--------- Gale	0-8	Silt loam-------	CL-ML, CL	A-4	0	100	100	90-100	70-90	20-30	5-10
	8-26	Silt loam, silty clay loam.	CL	A-6	0	100	100	90-100	70-95	25-40	10-22
	26-30	Loam, silt loam, fine sandy loam.	CL, CL-ML	A-4, A-6	0	100	100	65-100	50-95	20-30	5-12
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
177B, 177C, 177D--- Gotham	0-9	Loamy sand------	SM, SP-SM	A-2	0	100	95-100	35-75	5-25	---	NP
	9-33	Loamy fine sand, loamy sand.	SM, SP-SM	A-2	0	95-100	75-100	35-75	5-25	---	NP
	33-60	Sand, fine sand, loamy sand.	SM, SP-SM, SP	A-2, A-3	0	95-100	75-100	35-75	1-20	---	NP
189---------- Auburndale	0-17	Silt loam-------	CL, ML, CL-ML	A-4	0	100	100	95-100	95-100	20-30	2-10
	17-45	Silt loam-------	CL	A-6	0	100	100	95-100	70-100	25-35	10-20
	45-60	Sandy loam, gravelly sandy loam, loam.	SM, ML, CL-ML, SM-SC	A-4	0-5	75-90	65-90	60-80	35-55	<20	NP-5
225---------- Nessel	0-13	Fine sandy loam	SM, SM-SC	A-4	0-2	100	95-100	75-90	35-50	<20	NP-5
	13-41	Loam, clay loam, fine sandy loam.	CL	A-7, A-6	2-5	90-100	85-100	80-95	50-75	35-50	15-25
	41-60	Loam, fine sandy loam.	CL, ML, SC, SM	A-6, A-4	2-5	90-100	85-100	75-90	40-70	20-40	3-15

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
259B---------- Grays	0-11	Silt loam-------	CL	A-4, A-6	0	100	95-100	90-100	80-95	25-40	8-20
	11-48	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	95-100	90-100	60-90	30-45	15-25
	48-60	Stratified silt loam to very fine sand.	ML, CL, SM, SC	A-4, A-2, A-6	0	90-100	80-100	70-100	30-70	15-40	NP-20
264---------- Freeon	0-18	Silt loam-------	ML, CL, CL-ML	A-4	0	90-100	90-100	85-95	65-80	20-30	3-10
	18-30	Silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0	90-100	90-100	85-95	75-90	25-35	5-15
	30-54	Loam, sandy loam, fine sandy loam.	ML, SC, CL, SM	A-4, A-6, A-2	0-5	70-90	70-90	50-85	25-65	<30	NP-11
	54-60	Sandy loam, fine sandy loam, loamy sand.	SM, SM-SC, SC	A-4, A-2, A-6	0-5	70-90	70-90	35-75	10-50	<30	NP-15
265---------- Soderville	0-17	Loamy fine sand	SM, SP-SM	A-2, A-3	0	100	100	95-100	6-35	---	NP
	17-47	Fine sand, loamy fine sand, fine sandy loam.	SM, SP-SM	A-2, A-3	0	100	100	95-100	6-35	---	NP
	47-60	Fine sand, sand	SP, SP-SM, SM	A-2, A-3	0	100	85-100	95-100	2-20	---	NP
266---------- Freer	0-12	Silt loam-------	ML, CL-ML, CL	A-4, A-6	0-2	95-100	93-100	90-100	80-98	25-40	5-12
	12-23	Loam, silt loam	CL, ML, CL-ML	A-4, A-6	1-10	80-95	70-90	60-80	50-80	25-40	5-12
	23-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	1-10	75-95	70-90	50-75	20-45	<20	NP
298, 298B---------- Richwood	0-19	Silt loam-------	ML	A-4	0	100	100	90-100	85-95	25-35	3-10
	19-49	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	100	90-100	85-95	20-35	5-15
	49-60	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	100	50-80	5-35	---	NP
301B---------- Lindstrom	0-37	Silt loam-------	ML	A-4	0	100	100	95-100	85-95	30-40	5-10
	37-58	Silt loam-------	ML, CL	A-4, A-6	0	100	100	95-100	85-95	30-40	9-14
	58-60	Loam, silt loam, very fine sandy loam.	ML	A-4	0	100	95-100	75-95	50-90	25-35	NP-5
302B, 302C---------- Rosholt	0-11	Sandy loam------	SM, SM-SC	A-2, A-1, A-4	0	75-100	75-100	30-70	15-40	<20	2-7
	11-21	Loam, gravelly sandy loam, sandy loam.	SM, ML, SM-SC, CL-ML	A-2, A-4, A-1	0	50-100	50-100	25-95	15-75	<20	NP-5
	21-31	Gravelly sandy loam, gravelly loamy sand, gravelly loamy coarse sand.	SM, GM, SP-SM, GP-GM	A-1, A-2, A-3	0-10	20-90	20-90	10-60	5-15	---	NP
	31-60	Sand and gravel	GP, SP, SP-SM, GP-GM	A-1	0-15	20-90	20-90	10-40	0-10	---	NP
325---------- Prebish	0-17	Loam------------	ML, SM	A-4	0-2	90-100	90-98	70-90	35-70	20-40	NP-10
	17-48	Sandy loam, fine sandy loam, loam.	SM	A-4, A-2	0-5	80-95	77-90	45-80	25-50	<20	NP-4
	48-60	Sandy loam, fine sandy loam.	SM	A-2	0-10	80-95	77-85	55-70	20-35	<20	NP-4

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
327, 327B, 327C---- Dickman	0-14	Sandy loam------	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	14-17	Sandy loam, fine sandy loam.	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-45	15-25	2-8
	17-60	Stratified loamy fine sand to sand.	SP-SM	A-3, A-2	0	95-100	85-95	50-80	5-20	---	NP
329---------- Chaska	0-6	Silt loam-------	OL, CL, ML	A-4, A-6	0	100	100	90-100	70-80	30-40	5-15
	6-36	Stratified silt loam to loamy fine sand.	CL, CL-ML, ML	A-4, A-6	0	100	100	85-95	60-75	20-40	5-15
	36-60	Stratified silt loam to fine sand.	SM, ML, CL-ML, SM-SL	A-4	0	100	100	85-95	35-75	15-35	NP-7
340B, 340C--------- Whalan	0-12	Silt loam, loam	ML	A-4	0	100	95-100	85-95	60-90	30-40	5-10
	12-18	Clay loam, loam	CL	A-6	0	95-100	95-100	80-95	70-90	30-40	10-15
	18-26	Clay loam, silty clay, loam.	CL, CH	A-7	0-5	80-100	70-95	65-90	50-85	40-50	20-30
	26	Weathered bedrock.	---	---	---	---	---	---	---	---	---
342B, 342C, 342D, 342E---------- Kingsley	0-8	Sandy loam------	SM	A-2, A-4	0-5	90-100	75-100	50-85	30-45	<20	NP
	8-39	Sandy loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	75-95	50-75	25-45	10-20	3-8
	39-60	Sandy loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	75-95	50-75	25-40	10-20	2-7
367B---------- Campia	0-15	Silt loam-------	CL-ML, CL	A-4	0	100	100	90-100	70-95	20-30	5-10
	15-40	Silt loam, silty clay loam.	CL	A-6	0	100	100	90-100	70-95	30-39	13-22
	40-60	Silt loam, silt	CL, CL-ML	A-4, A-6	0	100	100	85-100	65-95	20-35	6-15
408---------- Faxon	0-19	Silt loam-------	CL	A-7	0-10	95-100	85-100	85-100	80-95	40-50	15-25
	19-34	Loam, sandy loam, silt loam.	CL, ML, SC, SM	A-7, A-6	0-10	95-100	70-100	65-95	40-85	30-50	10-20
	34	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
411, 411B, 411C---- Waukegan	0-10	Silt loam-------	ML	A-4	0	95-100	95-100	95-100	85-95	25-40	3-10
	10-24	Silt loam, silty clay loam.	CL-ML, CL	A-4, A-6	0	95-100	95-100	95-100	85-95	25-40	5-15
	24-60	Gravelly coarse sand, coarse sand.	SP, SW, SP-SM	A-1	0-2	80-95	65-90	30-50	3-10	---	NP
449---------- Crystal Lake	0-9	Silt loam-------	CL-ML, CL	A-4	0	100	100	90-100	70-95	20-30	5-10
	9-38	Silt loam, silty clay loam.	CL	A-6	0	100	100	90-100	70-95	30-39	13-22
	38-60	Silt loam, silt	CL, CL-ML	A-4, A-6	0	100	100	85-100	65-95	20-35	6-15
452---------- Comstock	0-19	Silt loam-------	CL-ML, CL	A-4	0	100	100	90-100	70-90	20-30	5-10
	19-40	Silt loam, silty clay loam, loam.	CL	A-6	0	100	100	90-100	70-95	30-39	13-22
	40-60	Stratified silt to very fine sand.	CL, ML, SM, SC	A-4, A-6	0	100	100	85-100	35-95	20-35	NP-15
453B, 453C, 453D--- Demontreville	0-24	Loamy fine sand, loamy sand.	SM	A-2	0-5	90-100	85-100	65-80	20-35	<20	NP
	24-41	Sandy loam, sandy clay loam, loam.	SC, SM, CL, ML	A-2, A-4	0-5	80-100	70-90	55-70	20-55	15-25	3-10
	41-60	Sandy loam, coarse sandy loam.	SC, SM, SM-SC	A-2, A-4, A-1	0-5	80-100	70-90	45-65	20-40	15-25	3-8

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
454B, 454C, 454D, 454F	0-8	Loamy sand, sand	SM, SM-SC	A-2, A-1	0-1	95-100	60-90	40-70	15-30	<20	NP-4
Mahtomedi	8-30	Sand, coarse sand, gravelly coarse sand.	SP-SM, SM	A-2, A-3, A-1	0-15	70-95	50-90	30-70	5-15	<20	NP
	30-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-5	75-95	50-90	30-70	2-15	<20	NP
456	0-7	Silt loam	ML, CL, CL-ML	A-4	0	100	100	90-100	75-95	20-30	3-12
Barronett	7-39	Silt loam, silty clay loam.	CL	A-6	0	100	100	90-100	75-100	20-35	10-25
	39-60	Stratified silty clay loam to very fine sand.	CL, ML, SM, SC	A-4, A-6	0	100	100	75-100	20-95	20-30	NP-12
460B, 460C	0-19	Silt loam	ML, CL	A-4, A-6	0	100	100	90-100	60-85	20-40	3-15
Baytown	19-32	Silt loam, loam, fine sandy loam.	ML, CL	A-4, A-6	0	100	95-100	80-100	50-90	25-40	3-15
	32-36	Sand, fine sand, loamy sand.	SM, SP-SM	A-1, A-2, A-3	0	90-100	85-100	45-75	5-20	<20	NP-3
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
468	0-38	Silt loam	CL	A-6, A-7	0	100	98-100	90-100	80-100	30-45	10-20
Otter	38-60	Stratified silt loam to sandy loam.	CL, ML, SM, SC	A-4, A-6	0	90-100	80-100	55-95	45-85	20-40	3-20
472B, 472C, 472D	0-8	Silt loam	CL	A-6, A-4	0-20	95-100	95-100	85-100	65-90	21-38	7-18
Channahon	8-18	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0-20	95-100	90-100	85-100	50-85	30-46	15-25
	18-60	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
481	0-11	Fine sandy loam	SM, SM-SC, SC	A-4	0	100	100	50-80	36-50	15-25	NP-8
Kratka	11-29	Loamy fine sand, fine sand, sand.	SP-SM	A-3, A-2	0	100	100	50-80	5-10	---	NP
	29-60	Loam, fine sandy loam, sandy clay loam.	SM-SC, SC, CL-ML, CL	A-4, A-6	0	95-100	90-100	70-90	40-60	15-40	4-25
488F	0-7	Flaggy loam	SM, SP-SM, SC, GM	A-2, A-1	7-30	30-65	20-55	15-45	8-35	12-30	NP-8
Brodale	7-13	Flaggy very fine sandy loam, flaggy silt loam.	SM, SC, GM, GC	A-2, A-4, A-1, A-6	20-50	30-65	20-55	15-45	12-45	10-35	NP-12
	13-50	Flaggy very fine sandy loam, flaggy silt loam.	SM, SC, SM-SC, GM	A-2, A-1	20-50	45-80	40-75	25-50	10-35	12-30	NP-8
	50	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
504B, 504C, 504D	0-9	Silt loam	ML, CL-ML	A-4	0-2	95-100	85-100	80-95	55-90	15-25	NP-5
Duluth	9-50	Loam, clay loam	CL, CL-ML	A-4, A-6	0-2	95-100	85-100	80-95	55-75	20-40	5-25
	50-60	Loam, clay loam, sandy loam.	CL, CL-ML	A-4, A-6	0-2	95-100	85-100	65-95	35-75	15-40	5-25

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
507---------- Poskin	0-13	Silt loam-------	ML, CL, CL-ML	A-4	0	100	100	90-100	70-90	20-30	3-10
	13-28	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	95-100	90-100	70-95	25-45	10-25
	28-33	Sandy loam, loam, gravelly sandy loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0-10	80-100	80-100	50-85	25-65	<20	2-6
	33-60	Sand and gravel	SP, SP-SM, GP, GP-GM	A-1, A-2, A-3	0-10	50-90	40-85	20-55	2-10	---	NP
529, 529B, 529C---- Ripon	0-24	Silt loam-------	ML, CL-ML, CL	A-4	0	100	100	90-100	70-90	20-30	3-10
	24	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
540---------- Seelyeville	0-60	Sapric and hemic material.	PT	A-8	0	---	---	---	---	---	---
541---------- Rifle	0-9	Sapric material	PT	A-8	0	---	---	---	---	---	---
	9-60	Hemic material	PT	A-8	0	---	---	---	---	---	---
543---------- Markey	0-30	Sapric material	PT	A-8	---	---	---	---	---	---	---
	30-60	Sand, loamy very fine sand, fine sand.	SP, SM, SP-SM	A-2, A-3	0	100	90-100	60-75	0-20	---	NP
544---------- Cathro	0-13	Sapric material	PT	A-8	0	---	---	---	---	---	---
	13-38	Sapric material, hemic material.	PT	A-8	0	---	---	---	---	---	---
	38-60	Sandy loam, loam, silt loam.	SM, ML, SC, CL	A-4	0	100	95-100	60-100	35-90	15-26	3-10
552---------- Kerston	0-20	Sapric material	PT	A-8	0	---	---	---	---	---	---
	20-24	Stratified fine sand to silty clay loam.	SM, ML	A-2, A-4, A-6, A-7	0	100	100	65-100	15-80	20-45	NP-15
	24-50	Sapric material	PT	A-8	0	---	---	---	---	---	---
	50-60	Stratified fine sand to silty clay loam.	SM, ML, SP-SM	A-2, A-4, A-6, A-7	0	100	95-100	55-95	10-75	20-45	NP-15
852B*: Urban land.											
Copaston----------	0-8	Loam----------	SM, ML	A-4	0	95-100	90-100	65-80	45-60	30-40	NP-10
	8-14	Fine sandy loam, sandy loam, loam.	SM	A-2, A-4	0	95-100	70-100	55-75	25-50	<35	NP-10
	14-18	Sandy loam, gravelly sandy loam.	SM	A-2	0-5	90-100	70-100	50-70	20-35	---	NP
	18	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
857*, 857C*: Urban land.											
Waukegan----------	0-10	Silt loam-------	ML	A-4	0	95-100	95-100	95-100	85-95	25-40	3-10
	10-24	Silt loam, silty clay loam.	CL-ML, CL	A-4, A-6	0	95-100	95-100	95-100	85-95	25-40	5-15
	24-60	Gravelly coarse sand, sand, coarse sand.	SP, SW, SP-SM	A-1	0-2	80-95	65-90	30-50	3-10	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
858*, 858C*: Urban land.											
Chetek	0-9	Sandy loam	SM, ML, SM-SC, CL-ML	A-2, A-4	0	95-100	95-100	60-85	25-55	<20	2-7
	9-18	Loam, sandy loam	ML, CL-ML, SM, SM-SC	A-2, A-4	0	95-100	95-100	60-95	25-60	15-30	2-10
	18-60	Sand and gravel	SP	A-1	0	85-95	65-75	40-50	1-5	---	NP
859B*: Urban land.											
Zimmerman	0-15	Loamy fine sand	SM	A-2	0	100	100	95-100	15-30	<20	NP
	15-60	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	100	95-100	5-20	<20	NP
860C*, 860D*: Urban land.											
Hayden	0-15	Fine sandy loam	SM, SM-SC, SC	A-4	0	100	95-100	65-85	35-50	20-30	NP-8
	15-50	Clay loam, loam	CL	A-7, A-6	0	95-100	90-98	80-95	55-75	30-50	15-26
	50-60	Loam, sandy loam, fine sandy loam.	CL, SC	A-6, A-4	0-5	95-100	90-98	75-90	35-70	20-15	8-15
Kingsley	0-8	Sandy loam	SM	A-2, A-4	0-5	90-100	75-100	50-85	30-45	<20	NP
	8-39	Sandy loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	75-95	50-75	25-45	10-20	3-8
	39-60	Sandy loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	75-95	50-75	25-40	10-20	2-7
861C*, 861D*: Urban land.											
Kingsley	0-8	Sandy loam	SM	A-2, A-4	0-5	90-100	75-100	50-85	30-45	<20	NP
	8-39	Sandy loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	75-95	50-75	25-45	10-20	3-8
	39-60	Sandy loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	75-95	50-75	25-40	10-20	2-7
862*: Urban land.											
Dundas	0-13	Fine sandy loam	SM, ML	A-4	0	100	95-98	85-95	40-60	20-30	NP-6
	13-45	Clay loam, silty clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-2	97-100	90-98	85-97	50-90	35-60	15-30
	45-60	Clay loam, loam, fine sandy loam.	CL, SC	A-6	0-2	95-100	90-98	80-95	35-70	30-40	10-20
863*: Urban land.											
Lino	0-9	Loamy fine sand	SM	A-2	0	100	100	95-100	15-30	<20	NP
	9-36	Fine sand, loamy fine sand.	SM, SP-SM	A-2	0	100	100	95-100	12-25	<20	NP
	36-60	Fine sand, sand	SM, SP-SM, SP	A-2, A-3	0	100	100	90-100	2-20	<20	NP

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
896C*, 896D*, 896F*:											
Mahtomedi	0-8	Loamy sand	SM, SM-SC	A-2, A-1	0-1	95-100	60-90	40-70	15-30	<20	NP-4
	8-30	Sand, coarse sand, gravelly coarse sand.	SP-SM, SM	A-2, A-3, A-1	0-15	70-95	50-90	30-70	5-15	<20	NP
	30-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-5	75-95	50-90	30-70	2-15	<20	NP
Kingsley	0-8	Sandy loam	SM	A-2, A-4	0-5	90-100	75-100	50-85	30-45	<20	NP
	8-39	Sandy loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	75-95	50-75	25-45	10-20	3-8
	39-60	Sandy loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	75-95	50-75	25-40	10-20	2-7
1013*. Pits, quarry											
1027*. Udorthents											
1029*. Pits, gravel											
1033*. Udifluvents											
1039*. Urban land											
1040*. Udorthents											
1055*. Aquolls and Histosols											
1813B	0-7	Loamy fine sand	SM	A-2	0	100	100	95-100	15-25	<20	NP
Lino Variant	7-60	Fine sand	SM, SP-SM	A-2, A-3	0	100	100	90-100	5-20	<20	NP
1819F*:											
Dorerton	0-10	Sandy loam, fine sandy loam.	SM, ML	A-4	0	100	95-100	55-80	35-55	<20	NP
	10-30	Channery loam, gravelly clay loam, flaggy clay loam.	GM, GC, SM, SC	A-2, A-1	0-20	40-75	30-65	20-45	12-35	30-45	5-20
	30-45	Very channery loam, very flaggy loam, flaggy loam sand.	GW-GM, SP-SM, SM	A-1, A-2	20-55	40-75	30-65	15-40	5-30	<20	NP
	45	Bedrock	---	---	---	---	---	---	---	---	
Rock outcrop.											
1820F*:											
Mahtomedi Variant	0-3	Sandy loam	SM, SM-SC, SC	A-4	0	100	100	70-85	35-50	10-25	NP-8
	3-32	Loamy sand, loamy fine sand.	SM	A-2	0	100	100	50-75	12-30	---	NP-4
	32-42	Fine sand, sand	SP, SP-SM	A-3	0	100	100	65-80	3-10	---	NP
	42	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1821----------	0-6	Loamy sand------	SM	A-2-4	0	100	100	50-75	15-30	---	NP
Algansee	6-60	Stratified sand to loam.	SM, SP-SM	A-3, A-2-4	0	100	100	50-70	5-15	---	NP
1827, 1827B--------	0-23	Silt loam-------	ML, CL	A-4, A-6	0	95-100	95-100	95-100	85-95	25-40	3-15
Waukegan Variant	23-40	Sand, fine sand, gravelly sand.	SP, SP-SM	A-1, A-3, A-2	0-2	80-95	65-85	30-60	3-10	---	NP
	40	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
1847----------	0-17	Silt loam-------	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	75-95	20-30	3-15
Barronett, sandy substratum	17-42	Silt loam, silty clay loam, loam.	CL	A-6	0	100	90-100	90-100	75-100	20-35	10-25
	42-60	Stratified loamy sand to gravelly sand.	SP, SP-SM	A-1, A-2, A-3	0-3	85-100	65-95	35-55	2-10	<20	NP
1848B----------	0-5	Loamy sand------	SM	A-2	0	100	100	50-75	15-25	---	NP
Sparta, bedrock substratum	5-40	Fine sand, sand	SM, SP-SM	A-2	0	100	100	55-75	10-25	---	NP
	40-44	Clay loam, clay	CL, CH, MH	A-7	0-2	90-100	80-95	80-90	60-75	40-60	20-30
	44	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm³	In/hr	In/in	pH					Pct
2, 2B, 2C--------	0-30	18-27	1.45-1.55	0.6-2.0	0.20-0.24	5.6-7.3	Low----------	0.28	5	6	3-5
Ostrander	30-36	18-27	1.45-1.55	0.6-2.0	0.17-0.20	5.1-7.3	Low----------	0.28			
	36-60	18-27	1.60-1.80	0.6-2.0	0.17-0.19	6.6-7.8	Low----------	0.37			
7B, 7C, 7D-------	0-20	4-10	1.45-1.60	6.0-20	0.08-0.12	5.1-7.3	Low----------	0.15	5	2	1-2
Hubbard	20-35	1-5	1.55-1.65	6.0-20	0.03-0.07	5.1-6.5	Low----------	0.15			
	35-60	0-5	1.55-1.65	6.0-20	0.03-0.07	6.1-7.3	Low----------	0.15			
8, 8B, 8C--------	0-28	3-10	1.20-1.40	6.0-20	0.10-0.12	5.1-7.3	Low----------	0.17	5	2	1-2
Sparta	28-60	2-8	1.40-1.60	6.0-20	0.06-0.11	5.1-6.0	Low----------	0.17			
12C, 12D---------	0-6	1-5	1.45-1.60	>20	0.06-0.10	5.1-6.5	Low----------	0.15	2	8	<1
Emmert	6-60	1-3	1.55-1.65	>20	0.02-0.04	5.1-7.3	Low----------	0.15			
49, 49B, 49C, 49D----------	0-8	10-15	1.25-1.35	0.6-2.0	0.22-0.24	4.5-6.5	Low----------	0.37	4	5	2-3
Antigo	8-13	8-15	1.30-1.35	0.6-2.0	0.20-0.22	4.5-6.5	Low----------	0.37			
	13-26	20-30	1.45-1.55	0.6-2.0	0.18-0.22	4.5-6.5	Moderate-----	0.37			
	26-38	8-15	1.45-1.75	0.6-2.0	0.10-0.19	4.5-6.5	Low----------	0.37			
	38-60	1-6	1.55-1.65	>20	0.02-0.04	5.1-7.8	Low----------	0.10			
75----------	0-19	14-25	1.25-1.40	0.6-2.0	0.20-0.24	5.6-6.5	Low----------	0.28	5	5	3-7
Bluffton	19-22	18-30	1.45-1.55	0.6-6.0	0.15-0.17	5.6-7.3	Low----------	0.28			
	22-60	18-30	1.50-1.65	0.2-0.6	0.15-0.19	7.4-8.4	Low----------	0.28			
100B, 100C-------	0-8	14-20	1.30-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.28	2	5	2-5
Copaston	8-14	14-20	1.40-1.60	0.6-6.0	0.15-0.17	5.6-7.3	Low----------	0.28			
	14-18	14-20	1.45-1.65	0.6-6.0	0.12-0.14	5.6-7.3	Low----------	0.28			
	18	---	---	---	---	---	----------	---			
113----------	0-16	20-36	1.35-1.40	0.2-0.6	0.19-0.21	6.6-7.3	Moderate-----	0.24	5	6	6-7
Webster	16-25	28-34	1.40-1.50	0.2-0.6	0.16-0.18	6.6-7.8	Moderate-----	0.32			
	25-60	23-29	1.50-1.70	0.2-0.6	0.17-0.19	7.4-8.4	Moderate-----	0.32			
120----------	0-11	10-15	1.25-1.35	0.6-2.0	0.22-0.24	4.5-6.5	Low----------	0.32	4	5	2-3
Brill	11-14	8-15	1.30-1.35	0.6-2.0	0.20-0.22	4.5-6.5	Low----------	0.43			
	14-35	20-30	1.45-1.55	0.6-2.0	0.18-0.22	4.5-6.5	Moderate-----	0.43			
	35-60	1-6	1.57-1.65	>20	0.02-0.04	5.1-7.3	Low----------	0.10			
123----------	0-9	5-15	1.45-1.60	0.6-2.0	0.15-0.20	5.6-7.3	Low----------	0.28	5	3	2-4
Dundas	9-45	20-35	1.50-1.65	0.2-0.6	0.15-0.19	5.1-7.3	Moderate-----	0.28			
	45-60	15-30	1.60-1.75	0.2-2.0	0.14-0.19	7.4-8.4	Moderate-----	0.28			
132B, 132C, 132D-	0-15	5-15	1.45-1.70	2.0-6.0	0.14-0.18	5.6-7.3	Low----------	0.32	5	3	.5-1
Hayden	15-50	18-35	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.32			
	50-60	15-27	1.65-1.80	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.32			
151, 151B--------	0-13	5-12	1.35-1.70	2.0-6.0	0.13-0.15	5.1-6.5	Low----------	0.20	3	3	2-4
Burkhardt	13-16	8-18	1.65-1.75	2.0-6.0	0.12-0.19	5.1-6.5	Low----------	0.20			
	16-60	1-6	1.50-1.60	6.0-20	0.02-0.04	5.6-6.5	Low----------	0.10			
153B, 153C-------	0-10	5-15	1.20-1.55	0.6-2.0	0.22-0.24	6.1-7.3	Low----------	0.37	5	5	2-4
Santiago	10-25	10-25	1.45-1.60	0.2-2.0	0.20-0.22	4.5-6.5	Low----------	0.37			
	25-60	3-15	1.75-1.90	0.2-2.0	0.08-0.19	5.6-7.3	Low----------	0.28			
155B----------	0-8	5-12	1.35-1.70	2.0-6.0	0.13-0.15	5.1-6.5	Low----------	0.20	3	3	1-2
Chetek	8-19	9-18	1.65-1.75	2.0-6.0	0.12-0.19	5.1-6.5	Low----------	0.20			
	19-60	1-6	1.50-1.60	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.10			
155C, 155D-------	0-9	5-12	1.35-1.70	2.0-6.0	0.13-0.15	5.1-6.5	Low----------	0.20	3	3	1-2
Chetek	9-18	9-18	1.65-1.75	2.0-6.0	0.12-0.19	5.1-6.5	Low----------	0.20			
	18-60	1-6	1.50-1.60	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.10			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm^3	In/hr	In/in	pH					Pct
158B, 158C, 158D-Zimmerman	0-15	2-10	1.40-1.60	6.0-20	0.10-0.12	4.5-6.5	Low	0.17	5	2	.5-1
	15-60	2-10	1.50-1.70	6.0-20	0.06-0.10	5.6-7.3	Low	0.17			
159, 159B-Anoka	0-9	2-10	1.40-1.60	2.0-20	0.13-0.16	5.1-6.0	Low	0.17	5	2	.5-1
	9-60	2-10	1.45-1.65	2.0-6.0	0.10-0.16	5.1-6.0	Low	0.17			
161-Isanti	0-13	2-10	1.35-1.55	6.0-20	0.10-0.12	4.5-6.5	Low	0.17	5	2	3-15
	13-42	2-10	1.45-1.65	6.0-20	0.06-0.08	4.5-6.5	Low	0.17			
	42-60	1-5	1.50-1.70	6.0-20	0.05-0.07	5.1-6.5	Low	0.17			
162-Lino	0-9	2-10	1.40-1.60	6.0-20	0.10-0.12	4.5-6.0	Low	0.17	5	2	.5-1
	9-36	2-10	1.50-1.70	6.0-20	0.06-0.08	4.5-6.0	Low	0.17			
	36-60	2-5	1.55-1.70	6.0-20	0.05-0.07	5.1-6.5	Low	0.17			
166-Ronneby	0-18	10-20	1.35-1.65	2.0-6.0	0.16-0.18	5.1-6.5	Low	0.28	5	3	2-4
	18-41	10-18	1.45-1.65	0.6-6.0	0.15-0.19	5.1-6.5	Low	0.28			
	41-60	2-15	1.75-1.90	0.2-0.6	0.07-0.13	6.1-8.4	Low	0.28			
169B, 169C-Braham	0-9	2-10	1.40-1.60	2.0-6.0	0.08-0.10	5.6-7.3	Low	0.17	5	2	.5-2
	9-28	2-10	1.40-1.70	6.0-20	0.07-0.10	5.6-6.5	Low	0.17			
	28-60	18-35	1.65-1.80	0.6-2.0	0.16-0.19	5.1-8.4	Low	0.32			
170-Blomford	0-9	2-10	1.40-1.60	6.0-20	0.10-0.12	5.1-7.3	Low	0.17	5	2	1-4
	9-25	2-10	1.40-1.70	6.0-20	0.06-0.11	5.1-7.3	Low	0.17			
	25-39	15-30	1.65-1.80	0.6-2.0	0.15-0.19	5.1-7.3	Moderate	0.37			
	39-60	15-30	1.65-1.80	0.6-2.0	0.14-0.19	6.1-8.4	Low	0.37			
174C, 174F-Gale	0-8	15-20	1.40-1.55	0.6-2.0	0.22-0.24	5.1-7.3	Low	0.37	4	5	1-2
	8-26	18-34	1.50-1.70	0.6-2.0	0.18-0.22	5.1-6.5	Moderate	0.37			
	26-30	18-34	1.50-1.70	0.6-2.0	0.17-0.22	5.1-6.5	Low	0.37			
	30	---	---	---	---	---	---	---			
177B, 177C, 177D-Gotham	0-9	2-4	1.35-1.55	2.0-6.0	0.10-0.12	5.6-7.3	Low	0.17	5	2	1-2
	9-33	3-8	1.40-1.60	6.0-20	0.09-0.11	5.1-7.3	Low	0.17			
	33-60	1-3	1.50-1.70	6.0-20	0.05-0.10	5.1-7.3	Low	0.17			
189-Auburndale	0-17	6-20	1.35-1.55	0.6-2.0	0.22-0.24	5.1-6.0	Low	0.37	5	5	6-12
	17-45	10-24	1.55-1.65	0.2-2.0	0.20-0.22	4.5-5.5	Moderate	0.37			
	45-60	6-15	1.65-1.70	0.6-6.0	0.10-0.12	6.1-7.3	Low	0.28			
225-Nessel	0-13	5-15	1.40-1.60	2.0-6.0	0.16-0.20	5.6-7.3	Low	0.24	5	3	2-3
	13-41	18-30	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate	0.32			
	41-60	15-27	1.60-1.75	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.32			
259B-Grays	0-11	20-29	1.30-1.55	0.6-2.0	0.22-0.24	5.6-7.3	Low	0.32	5-4	6	1-2
	11-48	25-35	1.35-1.60	0.6-2.0	0.18-0.20	5.1-6.5	Moderate	0.43			
	48-60	5-20	1.35-1.55	0.6-6.0	0.14-0.22	7.4-8.4	Low	0.43			
264-Freeon	0-18	5-18	1.25-1.55	0.6-2.0	0.22-0.24	4.5-7.3	Low	0.37	5	5	1-3
	18-30	18-30	1.35-1.65	0.6-2.0	0.18-0.22	4.5-6.5	Moderate	0.37			
	30-54	15-30	1.70-1.80	0.2-2.0	0.15-0.19	4.5-6.5	Low	0.37			
	54-60	3-17	1.70-1.95	0.2-2.0	0.08-0.16	5.6-7.3	Low	0.28			
265-Soderville	0-17	2-10	1.40-1.60	6.0-20	0.10-0.12	5.1-6.0	Low	0.15	5	2	.5-1
	17-47	6-12	1.45-1.75	6.0-20	0.06-0.11	5.1-6.0	Low	0.15			
	47-60	2-5	1.45-1.75	6.0-20	0.05-0.10	5.6-6.5	Low	0.15			
266-Freer	0-12	10-20	1.40-1.60	0.6-2.0	0.24-0.30	5.1-6.5	Low	0.37	5	5	.5-1
	12-23	18-28	1.40-1.60	0.6-2.0	0.14-0.21	5.1-5.5	Low	0.37			
	23-60	5-15	1.70-1.85	0.2-0.6	0.10-0.14	6.1-7.3	Low	0.37			
298, 298B-Richwood	0-19	15-22	1.35-1.60	0.6-2.0	0.22-0.24	5.6-7.3	Low	0.32	5	5	2-5
	19-49	18-34	1.55-1.65	0.6-2.0	0.18-0.22	5.6-7.3	Moderate	0.43			
	49-60	1-4	1.55-1.65	6.0-20	0.05-0.07	6.1-7.3	Low	0.15			
301B-Lindstrom	0-37	18-24	1.20-1.30	0.6-2.0	0.22-0.26	5.6-7.3	Low	0.32	5	5	3-5
	37-58	18-24	1.30-1.40	0.6-2.0	0.20-0.22	5.6-6.5	Low	0.43			
	58-60	12-20	1.40-1.50	0.6-2.0	0.17-0.19	6.6-7.8	Low	0.43			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm³	In/hr	In/in	pH					Pct
302B, 302C------- Rosholt	0-11 11-21 21-31 31-60	4-10 12-20 6-10 0-2	1.55-1.75 1.70-1.78 1.55-1.65 1.55-1.65	0.6-6.0 0.6-6.0 6.0-20 >20	0.10-0.15 0.06-0.19 0.04-0.09 0.02-0.04	5.1-6.5 5.1-6.5 5.1-6.5 5.1-6.5	Low---------- Low---------- Low---------- Low----------	0.24 0.24 0.10 0.10	3	3	1-3
325-------------- Prebish	0-17 17-48 48-60	5-20 12-18 2-15	1.35-1.55 1.50-1.70 1.65-1.90	0.6-6.0 0.2-0.6 0.2-0.6	0.16-0.20 0.14-0.16 0.09-0.13	5.6-7.3 5.6-7.3 5.6-7.8	Low---------- Low---------- Low----------	0.28 0.28 0.28	5	8	3-7
327, 327B, 327C-- Dickman	0-14 14-17 17-60	10-18 8-18 0-4	1.40-1.60 1.30-1.60 1.60-1.80	2.0-6.0 2.0-20 6.0-20	0.13-0.15 0.12-0.14 0.02-0.07	6.1-7.3 5.6-6.5 5.6-7.3	Low---------- Low---------- Low----------	0.20 0.20 0.15	3	3	2-4
329-------------- Chaska	0-6 6-36 36-60	18-28 2-28 2-28	1.30-1.60 1.40-1.65 1.40-1.65	0.6-2.0 0.6-2.0 2.0-6.0	0.20-0.22 0.17-0.19 0.07-0.16	6.6-7.8 7.4-7.8 7.4-8.4	Low---------- Low---------- Low----------	0.28 0.28 0.28	5	4L	2-5
340B, 340C------- Whalan	0-12 12-18 18-26 26	18-25 18-35 35-60 ---	1.30-1.45 1.40-1.55 1.35-1.45 ---	0.6-2.0 0.6-2.0 0.06-2.0 ---	0.22-0.24 0.17-0.19 0.15-0.19 ---	5.6-7.3 5.1-6.5 5.6-7.8 ---	Low---------- Low---------- High---------- ----------	0.32 0.32 0.32 ---	4	6	1-2
342B, 342C, 342D, 342E---------- Kingsley	0-8 8-39 39-60	3-10 6-18 5-10	1.40-1.60 1.70-1.82 1.75-1.85	0.6-2.0 0.2-0.6 0.2-0.6	0.10-0.18 0.13-0.16 0.11-0.14	5.6-6.5 5.1-6.0 5.6-7.3	Low---------- Low---------- Low----------	0.20 0.20 0.28	5	3	2-4
367B------------- Campia	0-15 15-40 40-60	8-22 18-30 8-20	1.30-1.65 1.35-1.55 1.35-1.55	0.6-2.0 0.6-2.0 0.6-2.0	0.22-0.24 0.18-0.22 0.20-0.22	5.6-7.3 4.5-6.5 4.5-7.3	Low---------- Moderate----- Low----------	0.37 0.37 0.37	5	5	2-3
408-------------- Faxon	0-19 19-34 34	18-30 18-30 ---	1.20-1.40 1.40-1.60 ---	0.6-2.0 0.6-2.0 ---	0.17-0.22 0.12-0.19 ---	6.6-7.8 6.6-7.8 ---	Moderate----- Moderate----- ----------	0.28 0.28 ---	4	6	2-5
411, 411B, 411C-- Waukegan	0-10 10-24 24-60	18-30 18-30 1-10	1.35-1.55 1.35-1.55 1.50-1.70	0.6-2.0 0.6-2.0 6.0-20	0.22-0.24 0.20-0.22 0.02-0.04	5.6-7.3 5.1-7.3 5.6-7.8	Low---------- Low---------- Low----------	0.32 0.43 0.10	4	6	2-5
449-------------- Crystal Lake	0-9 9-38 38-60	8-20 18-30 8-20	1.30-1.65 1.35-1.55 1.35-1.55	0.6-2.0 0.6-2.0 0.6-2.0	0.22-0.24 0.18-0.22 0.20-0.22	5.6-6.5 4.5-6.0 4.5-7.3	Low---------- Low---------- Low----------	0.37 0.37 0.37	5	5	.5-2
452-------------- Comstock	0-19 19-40 40-60	8-22 18-30 8-20	1.30-1.65 1.35-1.55 1.35-1.55	0.6-2.0 0.6-2.0 0.6-2.0	0.22-0.24 0.18-0.22 0.20-0.22	5.6-6.5 4.5-6.5 5.1-6.5	Low---------- Low---------- Low----------	0.37 0.37 0.37	5	5	2-3
453B, 453C, 453D- Demontreville	0-24 24-41 41-60	2-6 6-22 5-10	1.50-1.68 1.70-1.82 1.75-1.85	6.0-20 0.2-0.6 0.2-0.6	0.10-0.12 0.12-0.19 0.10-0.13	5.6-7.3 5.6-6.5 5.6-7.3	Low---------- Low---------- Low----------	0.17 0.28 0.28	5	2	.5-1
454B, 454C, 454D, 454F---------- Mahtomedi	0-8 8-30 30-60	5-10 0-10 0-3	1.50-1.75 1.48-1.65 1.42-1.60	6.0-20 6.0-20 6.0-20	0.10-0.12 0.05-0.07 0.07-0.09	5.1-6.5 5.1-7.8 5.1-6.5	Low---------- Low---------- Low----------	0.15 0.15 0.15	5	2	<1
456-------------- Barronett	0-7 7-39 39-60	5-15 15-29 10-18	1.25-1.45 1.35-1.55 1.35-1.55	0.6-2.0 0.2-0.6 0.2-2.0	0.22-0.24 0.18-0.22 0.17-0.22	5.1-6.5 5.1-6.5 6.6-7.8	Low---------- Moderate----- Low----------	0.37 0.37 0.37	5	5	3-7
460B, 460C------- Baytown	0-19 19-32 32-36 36	15-27 18-27 2-15 ---	1.40-1.60 1.40-1.70 1.40-1.70 ---	0.6-2.0 0.6-2.0 6.0-20 ---	0.22-0.24 0.17-0.22 0.05-0.10 ---	5.1-7.3 4.5-6.5 5.1-6.5 ---	Low---------- Low---------- Low---------- ----------	0.32 0.32 0.15 ---	4	6	3-7
468-------------- Otter	0-38 38-60	18-24 12-20	1.20-1.30 1.40-1.50	0.6-2.0 0.6-2.0	0.22-0.24 0.12-0.21	6.1-7.8 6.6-8.4	Low---------- Low----------	0.28 0.28	5	6	5-8

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm³	In/hr	In/in	pH					Pct
472B, 472C, 472D--	0-8	18-30	1.30-1.45	0.6-2.0	0.20-0.24	6.1-8.4	Low	0.37	2-1	6	2-3
Channahon	8-18	18-30	1.30-1.45	0.6-2.0	0.15-0.22	6.1-8.4	Moderate	0.37			
	18-60	---	---	---	---	---		---			
481	0-11	5-15	1.30-1.50	2.0-6.0	0.13-0.18	5.6-7.8	Low	0.17	5	3	1-2
Kratka	11-29	2-10	1.45-1.65	6.0-20.	0.06-0.11	5.6-7.8	Low	0.17			
	29-60	10-30	1.45-1.75	0.2-0.6	0.11-0.19	6.6-8.4	Moderate	0.17			
488F	0-7	5-15	1.30-1.45	0.6-2.0	0.06-0.12	6.6-8.4	Low	0.20	2	8	.5-2
Brodale	7-13	5-15	1.30-1.45	0.6-2.0	0.06-0.12	7.4-8.4	Low	0.20			
	13-50	5-15	1.20-1.35	0.6-2.0	0.04-0.09	7.9-8.4	Low	0.20			
	50	---	---	---	---	---		---			
504B, 504C, 504D--	0-9	10-18	1.35-1.45	0.6-2.0	0.19-0.23	4.5-6.5	Low	0.37	5	5	.5-2
Duluth	9-50	18-30	1.55-1.75	0.06-0.6	0.14-0.18	5.6-7.3	Moderate	0.37			
	50-60	18-30	1.55-1.75	0.06-0.6	0.12-0.18	6.6-7.8	Low	0.37			
507	0-13	18-27	1.35-1.55	0.6-2.0	0.22-0.24	5.1-6.5	Low	0.37	4	5	.5-2
Poskin	13-28	18-30	1.35-1.55	0.6-2.0	0.18-0.20	4.5-5.5	Low	0.37			
	28-33	8-18	1.50-1.60	0.6-2.0	0.10-0.19	5.6-6.5	Low	0.37			
	33-60	0-5	1.55-1.65	>20	0.02-0.04	5.6-7.3	Low	0.10			
529, 529B, 529C--	0-24	10-18	1.35-1.55	0.6-2.0	0.20-0.22	5.6-7.8	Low	0.32	4	5	2-4
Ripon	24	---	---	---	---	---		---			
540	0-60	---	0.10-0.25	0.2-6.0	0.35-0.45	5.6-7.3		---	---	3	>25
Seelyeville											
541	0-9	---	0.20-0.35	>0.2	0.45-0.65	5.6-7.3		---	---	3	>25
Rifle	9-60	---	0.08-0.20	0.6-6.0	0.45-0.55	5.6-7.3		---			
543	0-30	---	0.15-0.45	0.2-6.0	0.35-0.45	5.6-7.8		---	---	3	55-85
Markey	30-60	---	1.58-1.64	6.0-20	0.03-0.08	6.1-8.4	Low	---			
544	0-13	---	0.28-0.45	0.2-6.0	0.45-0.55	5.6-7.8		---	---	3	60-85
Cathro	13-38	---	0.15-0.30	0.2-6.0	0.35-0.45	5.6-7.8		---			
	38-60	0-25	1.80-1.97	0.2-2.0	0.11-0.22	6.6-8.4	Low	---			
552	0-20	---	0.28-0.45	0.2-6.0	0.35-0.45	5.6-8.4		---	---	3	60-85
Kerston	20-24	0-10	1.45-1.73	0.6-20	0.08-0.20	5.6-8.4	Low	---			
	24-50	---	0.12-0.25	0.2-6.0	0.35-0.45	5.6-8.4		---			
	50-60	0-10	1.56-1.74	0.6-20	0.06-0.20	5.6-8.4	Low	---			
852B*:											
Urban land.											
Copaston	0-8	14-20	1.30-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.28	2	5	2-5
	8-14	14-20	1.40-1.60	0.6-6.0	0.15-0.17	5.6-7.3	Low	0.28			
	14-18	14-20	1.45-1.65	0.6-6.0	0.12-0.14	5.6-7.3	Low	0.28			
	18	---	---	---	---	---		---			
857*, 857C*:											
Urban land.											
Waukegan	0-10	18-30	1.35-1.55	0.6-2.0	0.22-0.24	5.6-7.3	Low	0.32	4	6	2-5
	10-24	18-30	1.35-1.55	0.6-2.0	0.20-0.22	5.1-7.3	Low	0.43			
	24-60	1-10	1.50-1.70	6.0-20	0.02-0.04	5.6-7.8	Low	0.10			
858*, 858C*:											
Urban land.											
Chetek	0-9	5-12	1.35-1.70	2.0-6.0	0.13-0.15	5.1-6.5	Low	0.20	3	3	2-3
	9-18	9-18	1.65-1.75	2.0-6.0	0.12-0.19	5.1-6.5	Low	0.20			
	18-60	1-6	1.50-1.60	6.0-20	0.05-0.07	5.1-6.5	Low	0.10			
859B*:											
Urban land.											

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm³	In/hr	In/in	pH					Pct
859B*:											
Zimmerman	0-15	2-10	1.40-1.60	6.0-20	0.10-0.12	4.5-6.5	Low	0.17	5	2	.5-1
	15-60	2-10	1.50-1.70	6.0-20	0.06-0.10	6.1-7.3	Low	0.17			
860C*, 860D*:											
Urban land.											
Hayden	0-15	5-15	1.45-1.70	2.0-6.0	0.14-0.18	5.6-7.3	Low	0.32	5	3	.5-1
	15-50	18-35	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate	0.32			
	50-60	15-27	1.65-1.80	0.6-2.0	0.14-0.19	7.4-8.4	Low	0.32			
Kingsley	0-8	3-10	1.40-1.60	0.6-2.0	0.10-0.18	5.6-6.5	Low	0.20	5	3	2-4
	8-39	6-18	1.70-1.82	0.2-0.6	0.13-0.16	5.1-6.0	Low	0.20			
	39-60	5-10	1.75-1.85	0.2-0.6	0.11-0.14	5.6-7.3	Low	0.28			
861C*, 861D*:											
Urban land.											
Kingsley	0-8	3-10	1.40-1.60	0.6-2.0	0.10-0.18	5.6-6.5	Low	0.20	5	3	2-4
	8-39	6-18	1.70-1.82	0.2-0.6	0.13-0.16	5.1-6.0	Low	0.20			
	39-60	5-10	1.75-1.85	0.2-0.6	0.11-0.14	5.6-7.3	Low	0.28			
862*:											
Urban land.											
Dundas	0-13	5-15	1.45-1.60	0.6-2.0	0.15-0.20	5.6-7.3	Low	0.28	5	3	2-4
	13-45	20-35	1.50-1.65	0.2-0.6	0.15-0.19	5.1-7.3	Moderate	0.28			
	45-60	15-30	1.60-1.75	0.6-2.0	0.14-0.19	7.4-8.4	Moderate	0.28			
863*:											
Urban land.											
Lino	0-9	2-10	1.40-1.60	6.0-20	0.10-0.12	4.5-6.0	Low	0.17	5	2	.5-1
	9-36	2-10	1.50-1.70	6.0-20	0.06-0.08	4.5-6.0	Low	0.17			
	36-60	2-5	1.55-1.70	6.0-20	0.05-0.07	5.1-6.5	Low	0.17			
896C*, 896D*, 896F*:											
Mahtomedi	0-8	5-10	1.50-1.75	6.0-20	0.10-0.12	5.1-6.5	Low	0.15	5	2	<1
	8-30	0-10	1.48-1.65	6.0-20	0.05-0.07	5.1-7.8	Low	0.15			
	30-60	0-5	1.42-1.60	6.0-20	0.07-0.09	5.1-6.5	Low	0.15			
Kingsley	0-8	3-10	1.40-1.60	0.6-2.0	0.10-0.18	5.6-6.5	Low	0.20	5	3	2-4
	8-39	6-18	1.70-1.82	0.2-0.6	0.13-0.16	5.1-6.0	Low	0.20			
	39-60	5-10	1.75-1.85	0.2-0.6	0.11-0.14	5.6-7.3	Low	0.28			
1813B	0-7	1-5	1.45-1.65	6.0-20	0.10-0.13	5.1-6.0	Low	0.15	5	2	1-2
Lino Variant	7-60	1-5	1.40-1.60	6.0-20	0.06-0.08	6.1-7.3	Low	0.15			
1819F*:											
Dorerton	0-10	5-15	1.35-1.45	2.0-6.0	0.14-0.18	5.1-7.3	Low	0.24	2	3	1-2
	10-30	18-35	1.30-1.45	0.6-2.0	0.17-0.19	5.1-7.8	Low	0.32			
	30-45	20-35	---	0.6-2.0	0.08-0.14	5.6-7.8	Low	0.24			
	45	2-25	---	2.0-6.0	0.03-0.09	7.4-7.8	Low	0.10			
Rock outcrop.											
1820F*:											
Mahtomedi Variant	0-3	5-15	1.50-1.75	2.0-6.0	0.13-0.17	5.1-6.5	Low	0.20	5	3	<1
	3-32	0-10	1.48-1.65	6.0-20	0.09-0.11	5.1-6.0	Low	0.10			
	32-42	0-3	1.42-1.60	6.0-20	0.05-0.07	5.1-6.5	Low	0.10			
	42	---	---	---	---	---	---	---			
Rock outcrop.											

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm^3	In/hr	In/in	pH					Pct
1821----------	0-6	0-15	1.29-1.72	6.0-20	0.10-0.12	5.6-7.3	Low----------	0.17	5	2	1-4
Algansee	6-60	0-18	1.72-1.92	>20	0.05-0.07	5.6-7.8	Low----------	0.17			
1827, 1827B------	0-23	18-26	1.20-1.50	0.6-2.0	0.20-0.24	5.6-6.5	Low----------	0.32	3	6	2-6
Waukegan Variant	23-40	1-6	1.50-1.70	6.0-20	0.06-0.08	5.6-7.3	Low----------	0.10			
	40	---	---	---	---	---	----------	---			
1847----------	0-17	16-22	1.30-1.35	0.6-2.0	0.20-0.24	5.1-6.5	Low----------	0.28	5	5	4-6
Barronett, sandy	17-42	20-28	1.38-1.42	0.2-2.0	0.16-0.22	5.1-6.5	Moderate-----	0.28			
substratum	42-60	0-5	1.57-1.62	>20	0.02-0.07	5.1-6.5	Low----------	0.10			
1848B----------	0-5	1-10	1.55-1.70	6.0-20	0.10-0.12	5.6-6.0	Low----------	0.17	5	2	.5-2
Sparta, bedrock	5-40	1-5	1.55-1.70	6.0-20	0.06-0.08	5.6-6.0	Low----------	0.17			
substratum	40-44	30-45	1.35-1.55	0.06-0.6	0.14-0.16	5.1-7.8	Moderate-----	0.32			
	44	---	---	---	---	---	----------	---			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the text explain terms such as "rare," "brief," "apparent," and "perched." The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
2, 2B, 2C--------- Ostrander	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
7B, 7C, 7D--------- Hubbard	A	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Low.
8, 8B, 8C---------- Sparta	A	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Moderate.
12C, 12D---------- Emmert	A	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Moderate.
49, 49B, 49C, 49D- Antigo	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	High.
75---------------- Bluffton	C/D	Frequent----	Brief to long.	Mar-May	0-2.0	Apparent	Nov-Jun	>60	---	High------	High------	Moderate.
100B, 100C-------- Copaston	D	None---------	---	---	>6.0	---	---	12-20	Hard	Moderate	Low-------	Low.
113--------------- Webster	B/D	None---------	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
120--------------- Brill	B	None---------	---	---	3.0-5.0	Apparent	Sep-May	>60	---	High------	Moderate	Moderate.
123--------------- Dundas	B/D	None---------	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	High------	High------	Moderate.
132B, 132C, 132D-- Hayden	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low-------	Moderate.
151, 151B--------- Burkhardt	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	High.
153B, 153C-------- Santiago	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	High.
155B, 155C, 155D-- Chetek	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Moderate	High.
158B, 158C, 158D-- Zimmerman	A	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	High.
159, 159B--------- Anoka	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low-------	Moderate.
161--------------- Isanti	A/D	None---------	---	---	0-2.0	Apparent	Oct-Jun	>60	---	Moderate	High------	Moderate.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
162---------- Lino	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jun	>60	---	Moderate	Low------	High.
166---------- Ronneby	C	None--------	---	---	1.5-3.0	Perched	Oct-Jun	>60	---	High-----	Moderate	Moderate.
169B, 169C-------- Braham	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
170---------- Blomford	B/D	None--------	---	---	0.5-1.5	Apparent	Apr-Jun	>60	---	Moderate	High-----	Moderate.
174C, 174F-------- Gale	B	None--------	---	---	>6.0	---	---	20-40	Rippable	High-----	Moderate	Moderate.
177B, 177C, 177D-- Gotham	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Moderate.
189---------- Auburndale	D	Frequent----	Brief-----	Nov-Apr	0-1.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
225---------- Nessel	B	None--------	---	---	3.0-5.0	Apparent	Nov-Jun	>60	---	High-----	Moderate	Moderate.
259B---------- Grays	B	None--------	---	---	4.0-6.0	Apparent	Feb-Apr	>60	---	High-----	Moderate	Moderate.
264---------- Freeon	B	None--------	---	---	2.0-3.0	Perched	Nov-May	>60	---	Moderate	Moderate	Moderate.
265---------- Soderville	A	None--------	---	---	2.0-4.0	Apparent	Nov-Jun	>60	---	Moderate	Low------	Moderate.
266---------- Freer	C	None--------	---	---	1.0-3.0	Perched	Nov-Jun	>60	---	High-----	High-----	Moderate.
298, 298B--------- Richwood	B	None to rare	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
301B---------- Lindstrom	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
302B, 302C-------- Rosholt	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
325---------- Prebish	C/D	Common------	Brief-----	Apr-Jun	0-1.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
327, 327B, 327C--- Dickman	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Moderate.
329---------- Chaska	B/D	Frequent----	Brief-----	Apr-Jun	1.0-3.0	Apparent	Nov-Jun	>60	---	High-----	High-----	Low.
340B, 340C-------- Whalan	B	None--------	---	---	>6.0	---	---	20-40	Rippable	Moderate	Moderate	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
342B, 342C, 342D, 342E---------- Kingsley	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Moderate.
367B---------- Campia	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Low------	Moderate.
408---------- Faxon	B/D	Common------	Very brief	Apr-May	0-1.0	Apparent	Nov-May	20-40	Hard	High-----	High-----	Low.
411, 411B, 411C--- Waukegan	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Moderate.
449---------- Crystal Lake	B	None--------	---	---	2.5-3.5	Apparent	Dec-Apr	>60	---	High-----	Moderate	High.
452---------- Comstock	C	Rare--------	---	---	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	High.
453B, 453C, 453D-- Demontreville	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Moderate.
454B, 454C, 454D, 454F---------- Mahtomedi	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	High.
456---------- Barronett	B/D	Common------	Brief-----	Nov-Jun	0-1.0	Apparent	Nov-Jun	>60	---	High-----	High-----	High.
460B, 460C-------- Baytown	B	None--------	---	---	>6.0	---	---	20-40	Rippable	High-----	Low------	High.
468---------- Otter	B/D	Frequent----	Brief-----	Apr-Jun	0-2.0	Apparent	Apr-Jun	>60	---	High-----	High-----	Low.
472B, 472C, 472D-- Channahon	D	None--------	---	---	>6.0	---	---	10-20	Hard	Moderate	Moderate	Low.
481---------- Kratka	B/D	Frequent----	Brief-----	Apr-Jun	0-3.0	Apparent	Nov-Jun	>60	---	Moderate	High-----	Low.
488F---------- Brodale	C	None--------	---	---	>6.0	---	---	40-60	Rippable	Moderate	Low------	Low.
504B, 504C, 504D-- Duluth	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
507---------- Poskin	C	Rare--------	---	---	1.0-3.0	Apparent	Sep-May	>60	---	High-----	Moderate	Moderate.
529, 529B, 529C--- Ripon	B	None--------	---	---	>6.0	---	---	20-40	Hard	High-----	Moderate	Moderate.
540---------- Seelyeville	A/D	Frequent----	Very long	Apr-Nov	0-2.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Moderate.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
541---------- Rifle	A/D	Frequent----	Long------	Nov-May	0-1.0	Apparent	Nov-Jun	>60	---	High-----	High-----	Low.
543---------- Markey	A/D	Frequent----	Long------	Nov-May	0-1.0	Apparent	Nov-Jun	>60	---	High-----	High-----	Low.
544---------- Cathro	A/D	Frequent----	Long------	Nov-May	0-1.0	Apparent	Nov-Jun	>60	---	High-----	High-----	Low.
552---------- Kerston	A/D	Frequent----	Long------	Mar-May	0-1.0	Apparent	Sep-Jun	>60	---	High-----	High-----	Low.
852B*: Urban land.												
Copaston----------	D	None--------	---	---	>6.0	---	---	12-20	Hard	Moderate	Low------	Low.
857*, 857C*: Urban land.												
Waukegan----------	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Moderate.
858*, 858C*: Urban land.												
Chetek------------	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Moderate	High.
859B*: Urban land.												
Zimmerman---------	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	High.
860C*, 860D*: Urban land.												
Hayden------------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
Kingsley----------	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Moderate.
861C*, 861D*: Urban land.												
Kingsley----------	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Moderate.
862*: Urban land.												
Dundas------------	B/D	None--------	---	---	0-3.0	Apparent	Nov-Jun	>60	---	High-----	High-----	Moderate.
863*: Urban land.												
Lino---------------	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jun	>60	---	Moderate	Low------	High.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
896C*, 896D*, 896F*:												
Mahtomedi	A	None	---	---	>6.0	---	---	>60	---	Low	Low	High.
Kingsley	B	None	---	---	>6.0	---	---	>60	---	Low	Low	Moderate.
1013*. Pits, quarry												
1027*. Udorthents												
1029*. Pits, gravel												
1033*. Udifluvents												
1039*. Urban land	---	---	---	---	1.0-4.0	---	---	---	---	---	---	---
1040*. Udorthents												
1055*. Aquolls and Histosols	---	---	---	---	0-1.0	---	---	---	---	---	---	---
1813B. Lino Variant	A	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	Low	Moderate.
1819F*:												
Dorerton	B	None	---	---	>6.0	---	---	45-70	Rippable	Low	Low	Moderate.
Rock outcrop.												
1820F*:												
Mahtomedi Variant	A	None	---	---	>6.0	---	---	40-80	Rippable	Low	Low	High.
Rock outcrop.												
1821. Algansee	B	Occasional	Long	Nov-May	1.0-2.0	Apparent	Nov-May	>60	---	Moderate	Low	Low.
1827, 1827B. Waukegan Variant	B	None	---	---	>6.0	---	---	30-45	Hard	Low	Low	Low.
1847. Barronett, sandy substratum	C	Frequent	Brief	Nov-Jun	0-1.0	Apparent	Sep-May	>60	---	High	High	Moderate.
1848B. Sparta, bedrock substratum	A	None	---	---	>6.0	---	---	40-60	Hard	Low	Low	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Algansee	Mixed, mesic Aquic Udipsamments
*Anoka	Coarse-loamy, mixed Eutric Glossoboralfs
Antigo	Fine-silty over sandy or sandy-skeletal, mixed Typic Glossoboralfs
Aquolls	Mixed, frigid Haplaquolls
Auburndale	Fine-silty, mixed, frigid Typic Glossaqualfs
Barronett	Fine-silty, mixed, frigid Mollic Ochraqualfs
Baytown	Fine-silty over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Blomford	Loamy, mixed, frigid Arenic Ochraqualfs
Bluffton	Fine-loamy, mixed, frigid Typic Haplaquolls
Braham	Loamy, mixed, Arenic Eutroboralfs
*Brill	Fine-silty over sandy or sandy-skeletal, mixed Typic Glossoboralfs
*Brodale	Loamy-skeletal, carbonatic, mesic Entic Hapludolls
Burkhardt	Sandy, mixed, mesic Typic Hapludolls
Campia	Fine-silty, mixed Typic Glossoboralfs
Cathro	Loamy, mixed, euic Terric Borosaprists
Channahon	Loamy, mixed, mesic Lithic Argiudolls
Chaska	Fine-loamy, mixed (calcareous), mesic Mollic Fluvaquents
Chetek	Coarse-loamy, mixed Eutric Glossoboralfs
*Comstock	Fine-silty, mixed Aquic Glossoboralfs
Copaston	Loamy, mixed, mesic Lithic Hapludolls
*Crystal Lake	Fine-silty, mixed Typic Glossoboralfs
Demontreville	Loamy, mixed Arenic Eutroboralfs
Dickman	Sandy, mixed, mesic Typic Hapludolls
Dorerton	Loamy-skeletal, mixed, mesic Typic Hapludalfs
*Duluth	Fine-loamy, mixed Glossic Eutroboralfs
Dundas	Fine-loamy, mixed, mesic Udollic Ochraqualfs
Emmert	Sandy-skeletal, mixed, frigid Typic Udorthents
Faxon	Fine-loamy, mixed, mesic Typic Haplaquolls
*Freeon	Fine-loamy, mixed Typic Glossoboralfs
Freer	Fine-loamy, mixed, frigid Aeric Ochraqualfs
Gale	Fine-silty over sandy or sandy-skeletal, mixed, mesic Typic Hapludalfs
Gotham	Sandy, mixed, mesic Psammentic Hapludalfs
*Grays	Fine-silty, mixed, mesic Mollic Hapludalfs
Hayden	Fine-loamy, mixed, mesic Typic Hapludalfs
Histosols	Euic, frigid Histosols
Hubbard	Sandy, mixed Udorthentic Haploborolls
Isanti	Sandy, mixed, frigid Typic Haplaquolls
Kerston	Euic, mesic Fluvaquentic Medisaprists
Kingsley	Coarse-loamy, mixed, mesic Mollic Hapludalfs
Kratka	Sandy over loamy, mixed, frigid Typic Haplaquolls
Lindstrom	Fine-silty, mixed, mesic Cumulic Hapludolls
Lino	Mixed, frigid Aquic Udipsamments
Lino Variant	Mixed, frigid Alfic Udipsamments
Mahtomedi	Mixed, frigid Typic Udipsamments
Mahtomedi Variant	Mixed, frigid Typic Udipsamment
Markey	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
Nessel	Fine-loamy, mixed, mesic Glossaquic Hapludalfs
*Ostrander	Fine-loamy, mixed, mesic Typic Hapludolls
*Otter	Fine-silty, mixed, mesic Cumulic Haplaquolls
*Poskin	Fine-silty over sandy or sandy-skeletal, mixed Aquic Glossoboralfs
Prebish	Coarse-loamy, mixed, frigid Typic Haplaquolls
Richwood	Fine-silty, mixed, mesic Typic Argiudolls
Rifle	Euic Typic Borohemists
Ripon	Fine-silty, mixed, mesic Typic Argiudolls
*Ronneby	Coarse-loamy, mixed, frigid Aeric Fragiaqualfs
Rosholt	Coarse-loamy, mixed Typic Glossoboralfs
Santiago	Fine-loamy, mixed Typic Glossoboralfs
Seelyeville	Euic Typic Borosaprists
Soderville	Sandy, mixed Aquic Glossoboralfs
Sparta	Sandy, mixed, mesic Entic Hapludolls
Udifluvents	Sandy, mixed, frigid Udifluvents
Udorthents	Mixed, frigid Udorthents
Waukegan	Fine-silty over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Waukegan Variant	Fine-silty over sandy or sandy skeletal, mixed, mesic Typic Hapludoll
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
Whalan	Fine-loamy, mixed, mesic Typic Hapludalfs
Zimmerman	Mixed, frigid Alfic Udipsamments

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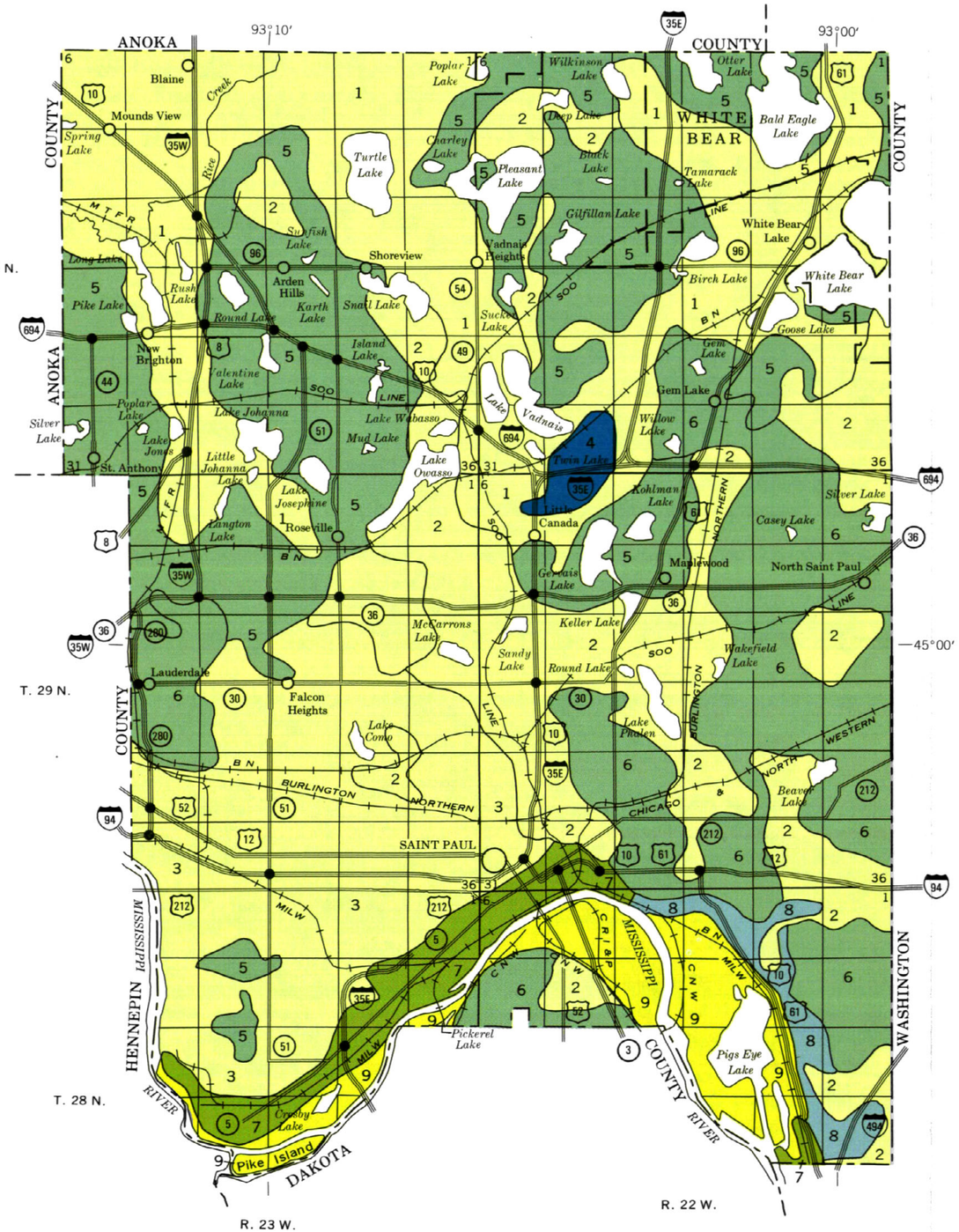


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MINNESOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

RAMSEY COUNTY, MINNESOTA

Scale 1:126,720

1 0 1 2 3 4 Miles

N

SOIL LEGEND*

SOILS FORMED DOMINANTLY IN OUTWASH

1 — Zimmerman–Urban Land–Rifle: Level to gently rolling, excessively drained and very poorly drained, coarse textured soils and organic soils and Urban land; on uplands

2 — Urban Land–Chetek–Mahtomedi: Urban land and nearly level to very steep, somewhat excessively drained and excessively drained, moderately coarse textured and coarse textured soils; on uplands

3 — Urban Land–Waukegan–Chetek: Urban land and nearly level to moderately steep, well drained and somewhat excessively drained, medium textured and moderately coarse textured soils; on uplands

SOILS FORMED DOMINANTLY IN LACUSTRINE SEDIMENTS

4 — Barronett–Grays: Level to gently sloping, poorly drained and moderately well drained, medium textured soils; on glacial lake plains

SOILS FORMED DOMINANTLY IN GLACIAL TILL

5 — Hayden–Urban Land: Undulating to steep, well drained, moderately coarse textured soils and Urban land; on uplands

6 — Kingsley–Urban Land: Undulating to steep, well drained, moderately coarse textured soils and Urban land; on uplands

SOILS FORMED DOMINANTLY IN LOAMY SEDIMENTS OVER BEDROCK

7 — Urban Land–Copaston: Urban land and level to moderately sloping, well drained, medium textured soils; on uplands

SOILS FORMED DOMINANTLY IN GLACIAL TILL OR OUTWASH

8 — Kingsley–Mahtomedi: Undulating to very steep, well drained and excessively drained, moderately coarse textured and coarse textured soils; on uplands

SOILS FORMED DOMINANTLY IN RECENT ALLUVIUM

9 — Udorthents, wet substratum–Algansee: Nearly level to very gently sloping, variably textured fill material and nearly level, somewhat poorly drained, coarse textured soils; on flood plains

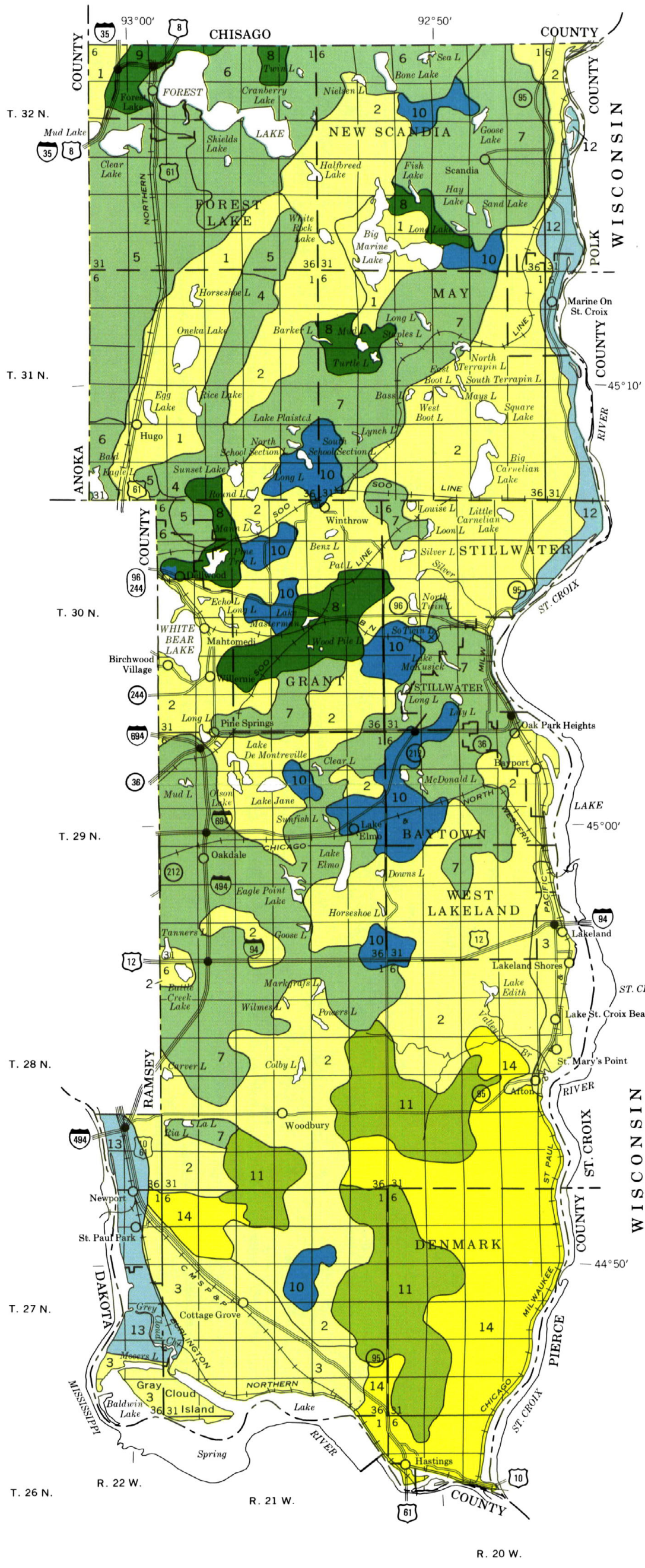
Compiled 1978

* Terms describing texture refer to the surface layer of the major soils in each map unit.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



N

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MINNESOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

WASHINGTON COUNTY, MINNESOTA

Scale 1:190,080

1 0 1 2 3 4 Miles

SOIL LEGEND*

SOILS FORMED DOMINANTLY IN OUTWASH

1 — Zimmerman–Isanti–Lino: Level to steep, excessively drained, somewhat poorly drained, and very poorly drained, coarse textured soils; on outwash plains

2 — Antigo–Chetek–Mahtomedi: Nearly level to steep, well drained to excessively drained, medium textured to coarse textured soils; mostly on outwash plains

3 — Sparta–Dickman–Hubbard: Level to moderately steep, excessively drained and somewhat excessively drained, moderately coarse textured and coarse textured soils; mostly on outwash terraces

SOILS FORMED DOMINANTLY IN GLACIAL TILL

4 — Hayden–Kingsley: Undulating to steep, well drained, moderately coarse textured soils; on uplands

5 — Nessel–Dundas–Webster: Level to gently undulating, moderately well drained and poorly drained, moderately coarse textured and medium textured soils; on uplands

6 — Hayden–Nessel–Dundas: Level to gently rolling, well drained, moderately well drained, and poorly drained, moderately coarse textured soils; on uplands

7 — Santiago–Kingsley: Undulating to steep, well drained, medium textured and moderately coarse textured soils; on uplands

SOILS FORMED DOMINANTLY IN A SANDY MANTLE AND THE UNDERLYING GLACIAL TILL AND IN GLACIAL TILL

8 — Demontreville–Kingsley: Undulating to steep, well drained, coarse textured and moderately coarse textured soils; on uplands

9 — Braham–Blomford–Urban Land: Nearly level to hilly, well drained and poorly drained, coarse textured soils and Urban land; on uplands

SOILS FORMED DOMINANTLY IN A SILTY MANTLE AND THE UNDERLYING SANDY OUTWASH AND IN SILTY LACUSTRINE SEDIMENTS

10 — Antigo–Comstock: Level to moderately sloping, well drained and somewhat poorly drained, medium textured soils; on outwash plains and glacial lake plains

SOILS FORMED DOMINANTLY IN A SILTY MANTLE AND THE UNDERLYING LOAMY GLACIAL TILL AND IN A SILTY MANTLE OVER BEDROCK

11 — Ostrander–Baytown–Ripon: Nearly level to moderately sloping, well drained, medium textured soils; on uplands

SOILS FORMED DOMINANTLY IN A SANDY OR LOAMY MANTLE OVER BEDROCK AND IN SANDY ALLUVIUM

12 — Mahtomedi Variant–Copaston: Moderately sloping to very steep, excessively drained and well drained, moderately coarse textured and medium textured soils; on terraces and escarpments

13 — Copaston–Sparta: Nearly level to moderately steep, well drained and excessively drained, medium textured and coarse textured soils; mostly on terraces

SOILS FORMED DOMINANTLY IN A SILTY MANTLE AND THE UNDERLYING SANDY OUTWASH AND IN A SILTY MANTLE OVER BEDROCK

14 — Waukegan–Baytown–Ripon: Level to moderately sloping, well drained, medium textured soils; on uplands

Compiled 1978

* Terms describing texture refer to the surface layer of the major soils in each map unit.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
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31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

INDEX TO MAP SHEETS

WASHINGTON COUNTY, MINNESOTA

N

Scale 1:190,080

1 0 1 2 3 4 Miles

93°00′ 92°50′ 45°10′ 45°00′ 44°50′

T. 32 N. T. 31 N. T. 30 N. T. 29 N. T. 28 N. T. 27 N. T. 26 N.

R. 22 W. R. 21 W. R. 20 W.

CHISAGO COUNTY · ANOKA COUNTY · POLK COUNTY · WISCONSIN · RAMSEY COUNTY · DAKOTA COUNTY · PIERCE COUNTY · WISCONSIN

FOREST · FOREST LAKE · NEW SCANDIA · MAY · STILLWATER · GRANT · BAYTOWN · WEST LAKELAND · DENMARK

Forest Lake · Mud Lake · Clear Lake · Shields Lake · Cranberry Lake · Twin L · Nielsen L · Sea L · Bone Lake · Goose Lake · Scandia · Halfbreed Lake · Fish Lake · Hay Lake · Sand Lake · White Rock Lake · Big Marine Lake · Long Lake · Horseshoe L · Oneka Lake · Barker L · Mud L · Staples L · Long L · Marine On St. Croix · Turtle L · North Terrapin L · East Boot L · South Terrapin L · West Boot L · Mays L · Square Lake · Bass L · Rice Lake · Bald Eagle Lake · Lake Plaisted · Hugo · North School Section L · South School Section L · Lynch L · Bald Eagle L · Sunset Lake · Long L · Round L · Big Carnelian Lake · Little Carnelian Lake · Louise L · Winthrow · Mann L · Pine Tree L · Benz L · Pat L · Silver L · Dellwood · Echo L · Long L · Lake Mastermans · North Twin L · So Twin L · WHITE BEAR LAKE · Mahtomedi · Wood Pile L · Birchwood Village · Willernie · Lake McKusick · Long L · Lily L · Pine Springs · Oak Park Heights · Lake De Montreville · Clear L · Bayport · McDonald L · Mud L · Olson Lake · Lake Jane · Sunfish L · Lake Elmo · Oakdale · Downs L · Eagle Point Lake · Horseshoe L · Tanners L · Goose L · Lakeland · Lakeland Shores · Markgrafs L · Wilmes L · Powers L · Lake Edith · Lake St. Croix Beach · Carver L · Colby L · St. Mary's Point · Afton · La L · Ria L · Woodbury · Newport · St. Paul Park · Grey Cloud Island · Baldwin Lake · Mooers L · Cottage Grove · Spring · Hastings

Inset, sheet 32 · Inset, sheet 52 · Inset, sheet 67 · Inset, sheet 71 · Inset, sheet 63

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
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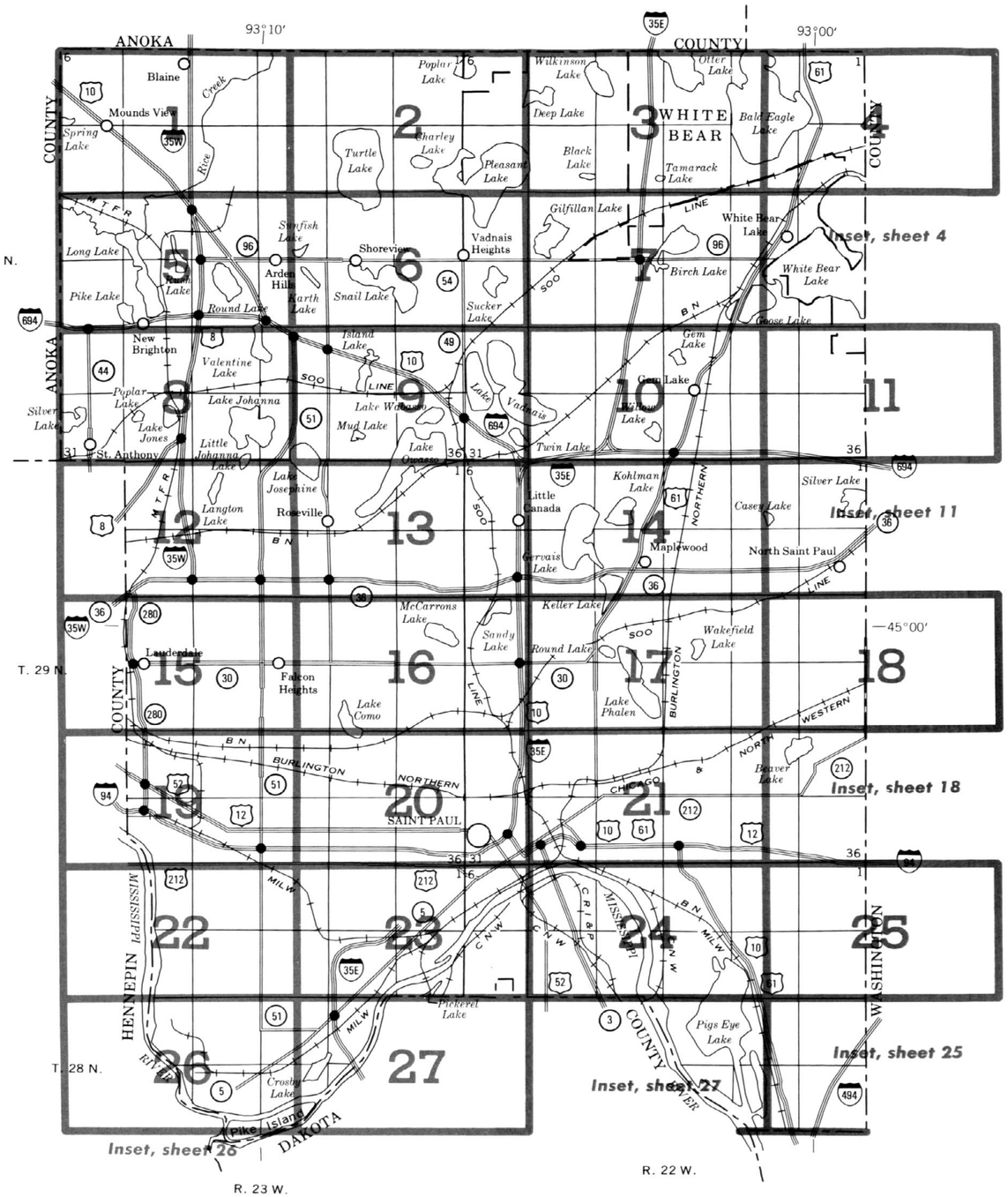

INDEX TO MAP SHEETS

RAMSEY COUNTY, MINNESOTA

Scale 1:126,720

1 0 1 2 3 4 Miles

N

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and letters; for example, 8, 123,7C, and 100B. The number or numbers designate the kind of soil and the letter the class of slope. Symbols without a slope letter are for level, nearly level, or very gently sloping soils or for miscellaneous areas.

SYMBOL	NAME
2	Ostrander silt loam, 0 to 2 percent slopes
2B	Ostrander silt loam, 2 to 6 percent slopes
2C	Ostrander silt loam, 6 to 12 percent slopes
7B	Hubbard loamy sand, 1 to 6 percent slopes
7C	Hubbard loamy sand, 6 to 12 percent slopes
7D	Hubbard loamy sand, 12 to 18 percent slopes
8	Sparta loamy sand, 0 to 2 percent slopes
8B	Sparta loamy sand, 2 to 6 percent slopes
8C	Sparta loamy sand, 6 to 15 percent slopes
12C	Emmert loamy coarse sand, 3 to 15 percent slopes
12D	Emmert gravelly loamy coarse sand, 15 to 25 percent slopes
49	Antigo silt loam, 0 to 2 percent slopes
49B	Antigo silt loam, 2 to 6 percent slopes
49C	Antigo silt loam, 6 to 12 percent slopes
49D	Antigo silt loam, 12 to 18 percent slopes
75	Bluffton loam
100B	Copaston loam, 0 to 6 percent slopes
100C	Copaston loam, 6 to 12 percent slopes
13	Webster loam
120	Brill silt loam
123	Dundas fine sandy loam
132B	Hayden fine sandy loam, 2 to 6 percent slopes
132C	Hayden fine sandy loam, 6 to 12 percent slopes
132D	Hayden fine sandy loam, 12 to 25 percent slopes
151	Burkhardt sandy loam, 0 to 3 percent slopes
151B	Burkhardt sandy loam, 3 to 9 percent slopes
153B	Santiago silt loam, 2 to 6 percent slopes
153C	Santiago silt loam, 6 to 15 percent slopes
155B	Chetek sandy loam, 0 to 6 percent slopes
155C	Chetek sandy loam, 6 to 12 percent slopes
155D	Chetek sandy loam, 12 to 25 percent slopes
158B	Zimmerman loamy fine sand, 0 to 6 percent slopes
158C	Zimmerman loamy fine sand, 6 to 12 percent slopes
158D	Zimmerman loamy fine sand, 12 to 25 percent slopes
159	Anoka loamy fine sand, 0 to 3 percent slopes
159B	Anoka loamy fine sand, 3 to 9 percent slopes
161	Isanti loamy fine sand
162	Lino loamy fine sand
166	Ronneby fine sandy loam
169B	Braham loamy fine sand, 1 to 6 percent slopes
169C	Braham loamy fine sand, 6 to 15 percent slopes
170	Blomford loamy fine sand
174C	Gale silt loam, 6 to 15 percent slopes
174F	Gale silt loam, 25 to 50 percent slopes
177B	Gotham loamy sand, 1 to 6 percent slopes
177C	Gotham loamy sand, 6 to 12 percent slopes
177D	Gotham loamy sand, 12 to 20 percent slopes
189	Auburndale silt loam
225	Nessel fine sandy loam, 1 to 4 percent slopes
259B	Grays silt loam, 2 to 6 percent slopes
264	Freeon silt loam, 1 to 4 percent slopes
265	Soderville loamy fine sand
266	Freer silt loam
298	Richwood silt loam, 0 to 2 percent slopes
298B	Richwood silt loam, 2 to 6 percent slopes
301B	Lindstrom silt loam, 2 to 4 percent slopes
302B	Rosholt sandy loam, 1 to 6 percent slopes
302C	Rosholt sandy loam, 6 to 15 percent slopes
325	Prebish loam
327	Dickman sandy loam, 0 to 2 percent slopes
327B	Dickman sandy loam, 2 to 6 percent slopes
327C	Dickman sandy loam, 6 to 12 percent slopes
329	Chaska silt loam
340B	Whalan silt loam, 1 to 6 percent slopes
340C	Whalan silt loam, 6 to 12 percent slopes
342B	Kingsley sandy loam, 2 to 6 percent slopes
342C	Kingsley sandy loam, 6 to 12 percent slopes
342D	Kingsley sandy loam, 12 to 18 percent slopes
342E	Kingsley sandy loam, 18 to 30 percent slopes
367B	Campia silt loam, 0 to 8 percent slopes
408	Faxon silt loam
411	Waukegan silt loam, 0 to 2 percent slopes
411B	Waukegan silt loam, 2 to 6 percent slopes
411C	Waukegan silt loam, 6 to 12 percent slopes
449	Crystal Lake silt loam, 1 to 3 percent slopes
452	Comstock silt loam
453B	Demontreville loamy fine sand, 2 to 6 percent slopes
453C	Demontreville loamy fine sand, 6 to 12 percent slopes
453D	Demontreville loamy fine sand, 12 to 25 percent slopes
454B	Mahtomedi loamy sand, 0 to 6 percent slopes
454C	Mahtomedi loamy sand, 6 to 12 percent slopes
454D	Mahtomedi loamy sand, 12 to 25 percent slopes
454F	Mahtomedi loamy sand, 25 to 40 percent slopes
456	Barronett silt loam
460B	Baytown silt loam, 1 to 6 percent slopes
460C	Baytown silt loam, 6 to 12 percent slopes
468	Otter silt loam
472B	Channahon silt loam, 1 to 6 percent slopes
472C	Channahon silt loam, 6 to 12 percent slopes
472D	Channahon silt loam, 12 to 18 percent slopes
481	Kratka fine sandy loam
488F	Brodale flaggy loam, 20 to 50 percent slopes
504B	Duluth silt loam, 1 to 6 percent slopes
504C	Duluth silt loam, 6 to 12 percent slopes
504D	Duluth silt loam, 12 to 25 percent slopes
507	Poskin silt loam
529	Ripon silt loam, 1 to 2 percent slopes
529B	Ripon silt loam, 2 to 6 percent slopes
529C	Ripon silt loam, 6 to 12 percent slopes
540	Seelyeville muck
541	Rifle muck
543	Markey muck
544	Cathro muck
552	Kerston muck
852B	Urban land–Copaston complex, 0 to 8 percent slopes
857	Urban land–Waukegan complex, 0 to 3 percent slopes
857C	Urban land–Waukegan complex, 3 to 15 percent slopes
858	Urban land–Chetek complex, 0 to 3 percent slopes
858C	Urban land–Chetek complex, 3 to 15 percent slopes
859B	Urban land–Zimmerman complex, 1 to 8 percent slopes
860C	Urban land–Hayden–Kingsley complex, 3 to 15 percent slopes
860D	Urban land–Hayden–Kingsley complex, 15 to 25 percent slopes
861C	Urban land–Kingsley complex, 3 to 15 percent slopes
861D	Urban land–Kingsley complex, 15 to 25 percent slopes
862	Urban land–Dundas complex, 1 to 4 percent slopes
863	Urban land–Lino complex, 0 to 3 percent slopes
896C	Mahtomedi–Kingsley complex, 3 to 12 percent slopes
896D	Mahtomedi–Kingsley complex, 12 to 25 percent slopes
896F	Mahtomedi–Kingsley complex, 25 to 40 percent slopes
1013	Pits, quarry
1027	Udorthents, wet substratum
1029	Pits, gravel
1033	Udifluvents
1039	Urban land
1040	Udorthents
1055	Aquolls and Histosols, ponded
1813B	Lino Variant loamy fine sand, 2 to 6 percent slopes
1819F	Dorerton–Rock outcrop complex, 25 to 65 percent slopes
1820F	Mahtomedi Variant–Rock outcrop complex, 25 to 60 percent slopes
1821	Algansee loamy sand
1827	Waukegan Variant silt loam, 0 to 2 percent slopes
1827B	Waukegan Variant silt loam, 2 to 9 percent slopes
1847	Barronett silt loam, sandy substratum
1848B	Sparta loamy sand, bedrock substratum, 0 to 6 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool (Davis Airstrip; FLOOD POOL LINE)

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate (79)
- Federal (410)
- State (52)
- County, farm or ranch (378)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small (water; W)

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) (Indian Mound)
- Located object (label) (Tower)
- Tank (label) (GAS)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) (CANAL)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial (water; WP)
- Intermittent (int; I)

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (75 / 153B)

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot (0)
- Muck spot
- Spot of better drained soil in a poorly drained area

WASHINGTON COUNTY, MINNESOTA NO. 1

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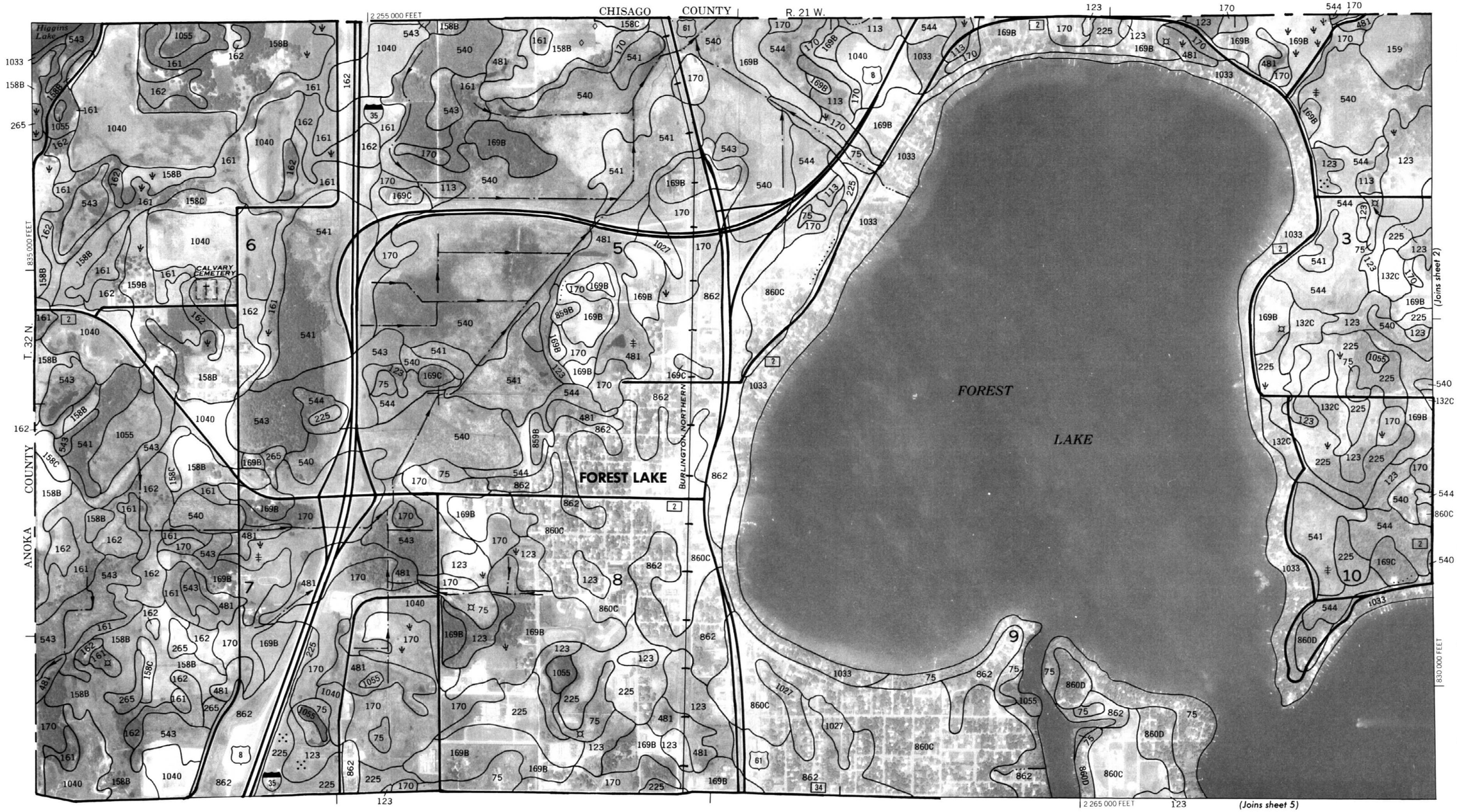

RAMSEY COUNTY, MINNESOTA NO. 1

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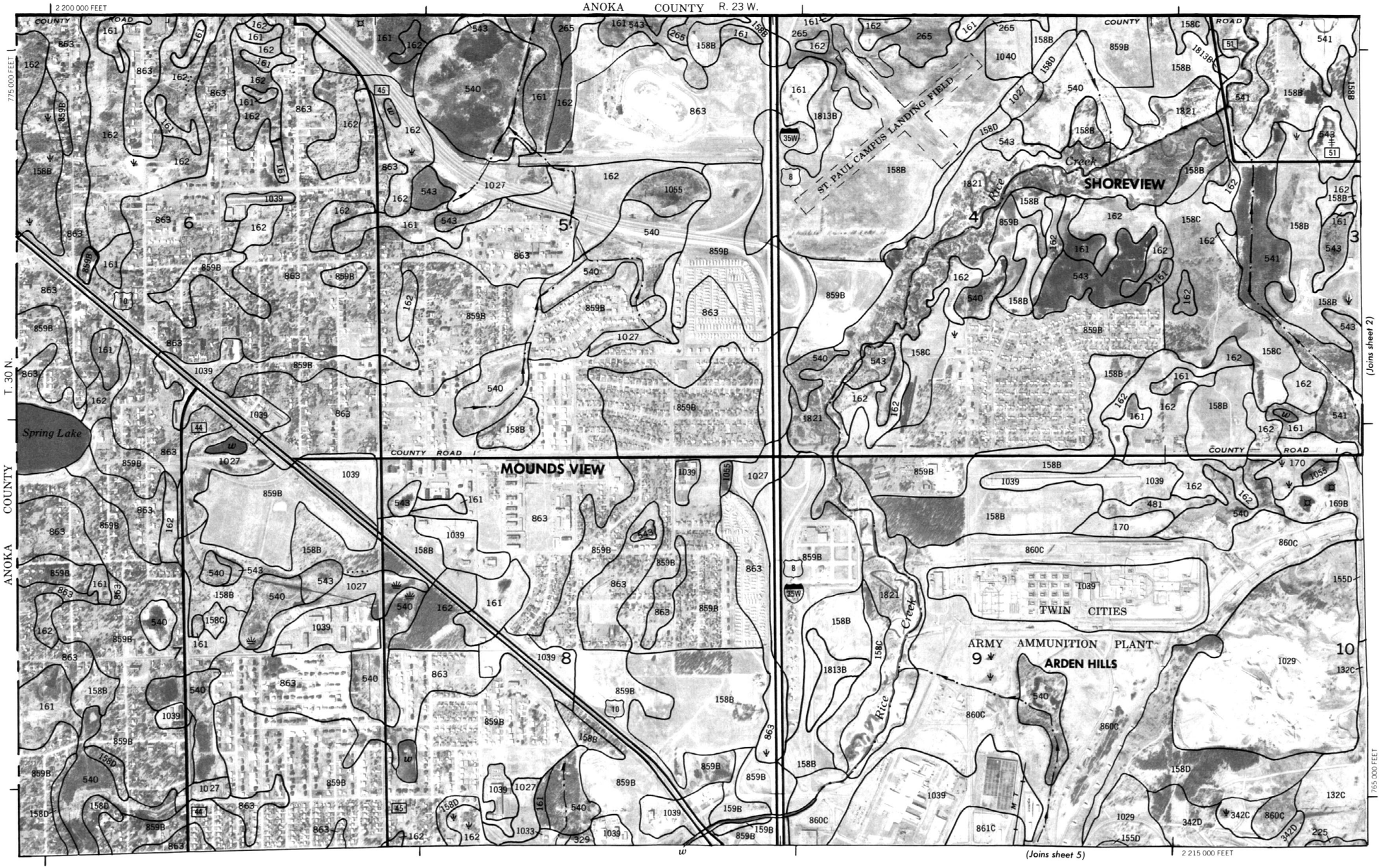

N

1 Mile
5 000 Feet

Scale 1:15 840

WASHINGTON COUNTY, MINNESOTA — SHEET NUMBER 2

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WASHINGTON COUNTY, MINNESOTA NO. 2

2

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 1)

ANOKA COUNTY

R. 23 W. | R. 22 W.

2 235 000 FEET

775 000 FEET

765 000 FEET

2 220 000 FEET

T. 30 N.

(Joins sheet 3)

(Joins sheet 6)

SHOREVIEW

TWIN CITIES ARMY AMMUNITION PLANT

LEXINGTON AVENUE

COUNTY ROAD J

COUNTY ROAD I

TURTLE LAKE

Poplar Lake

Charley Lake

Deep Lake

PLEASANT LAKE

NORTH OAKS

water

1 2 3 6 7 10 11 12

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RAMSEY COUNTY, MINNESOTA NO. 2

WASHINGTON COUNTY, MINNESOTA NO. 3

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3

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 20 W. CHISAGO COUNTY

2 290 000 FEET

1055

(Joins sheet 4)

835 000 FEET

T. 32 N.

(Joins sheet 2)

830 000 FEET

2 305 000 FEET (Joins sheet 7)

BONE LAKE

Sea Lake

Nielson Lake

Goose Lake

water

5

4

3

2

1

8

9

10

11

RAMSEY COUNTY, MINNESOTA NO. 3

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3

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 22 W.

ANOKA COUNTY

WASH CO

2 240 000 FEET

2 250 000 FEET

775 000 FEET

765 000 FEET

T. 30 N.

(Joins sheet 2)

(Joins sheet 4)

(Joins sheet 7)

WILKINSON LAKE

OTTER LAKE

BALD EAGLE LAKE

Deep Lake

PLEASANT LAKE

Black Lake

NORTH OAKS

ST. MARYS OF THE LAKE CEMETERY

500 LINE

COUNTY ROAD J

water

5 4 3 2 8 9 10 11

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WASHINGTON COUNTY, MINNESOTA NO. 4

(4)

N

1 Mile 5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

WASHINGTON COUNTY

R. 22 W.

2 260 000 FEET

775 000 FEET

T. 30 N.

WASHINGTON COUNTY

765 000 FEET

2 255 000 FEET

(Joins inset sheet 4)

(Joins sheet 3)

BALD EAGLE LAKE

BENSON AIRPORT

WHITE BEAR LAKE

White Bear Lake

NORTHERN

BURLINGTON

LINE

1 2 11 12

(Joins lower left)

(96)

R. 22 W.

2 260 000 FEET

760 000 FEET

T. 30 N.

WASHINGTON COUNTY

755 000 FEET

2 255 000 FEET

(Joins sheet 11)

(Joins sheet 7)

WHITE BEAR LAKE

Manitou Island

WHITE BEAR LAKE

Goose Lake

WHITE BEAR AVENUE

COUNTY ROAD F

13 14 23 24

NORTHERN

BURLINGTON

water

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RAMSEY COUNTY, MINNESOTA NO. 4

WASHINGTON COUNTY, MINNESOTA NO. 5

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 21 W.

T. 32 N

ANOKA COUNTY

(Joins sheet 1)

(Joins sheet 6)

(Joins sheet 9)

2 255 000 FEET

2 270 000 FEET

825 000 FEET

820 000 FEET

Mud Lake

CLEAR LAKE

Forest Lake

SCANDANAVIAN CEMETERY

BURLINGTON NORTHERN

FOREST LAKE AIRPORT

water

17

18

19

20

21

22

16

15

RAMSEY COUNTY, MINNESOTA NO. 5

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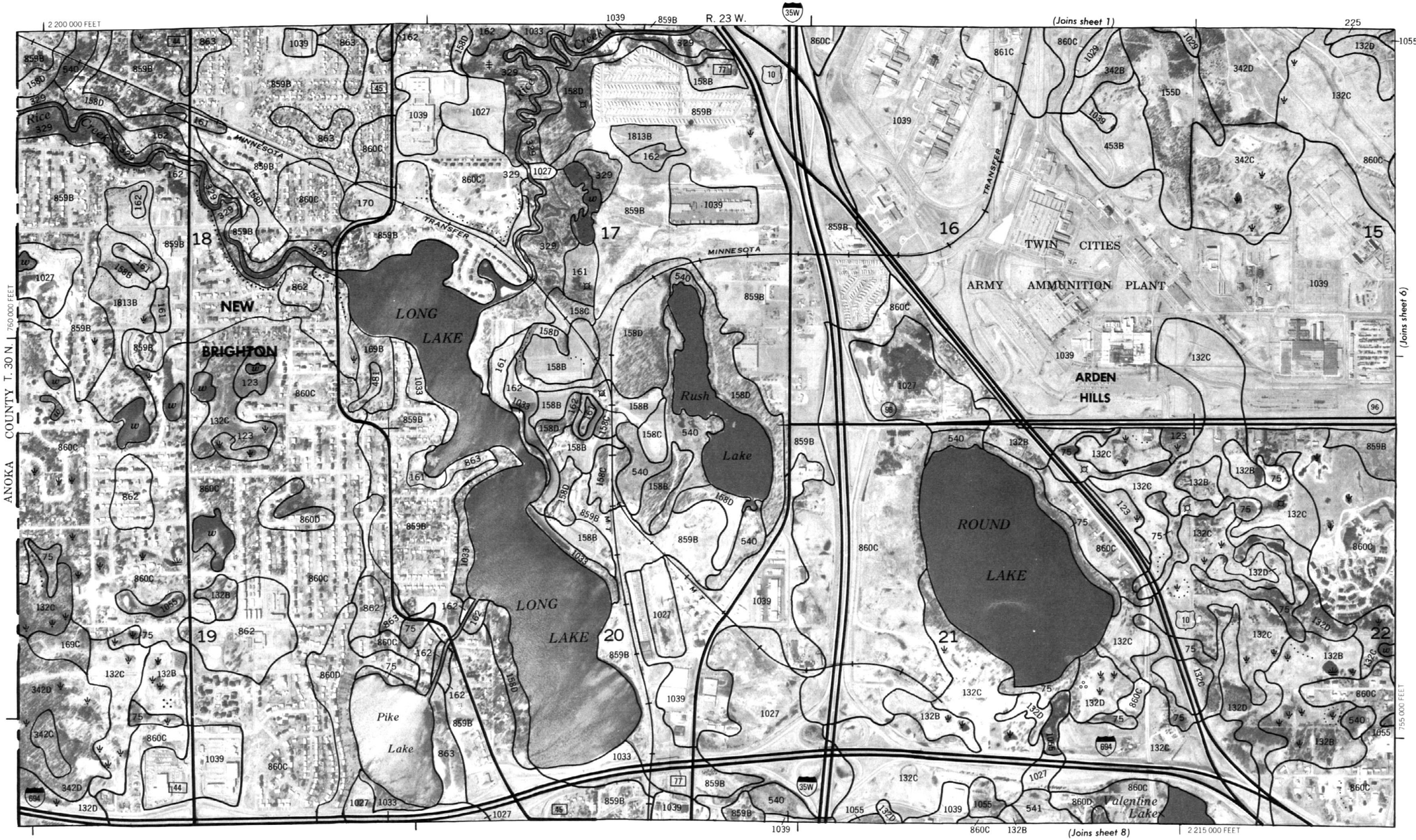

5

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0
¼ 1 000
½ 2 000
¾ 4 000
1 5 000

6

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

R. 21 W. | R. 20 W.

T. 32 N.

2 285 000 FEET

2 275 000 FEET

825 000 FEET

820 000 FEET

(Joins sheet 2)

(Joins sheet 5)

(Joins sheet 7)

(Joins sheet 10)

Forest Lake

FOREST LAKE

Shields Lake

Chippewa Heights

Hidden Valley

Halfbreed Lake

water

13 14 15 18 19 22 23 24

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 6

6

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

(Joins sheet 2)

R. 23 W. | R. 22 W.

2 235 000 FEET

760 000 FEET

755 000 FEET

2 220 000 FEET

(Joins sheet 5)

(Joins sheet 7)

(Joins sheet 9)

T. 30 N.

Turtle Lake

PLEASANT LAKE

SNAIL LAKE

Sucker Lake

Sunfish Lake

Karth Lake

TWIN CITIES ARMY AMMUNITION PLANT

NORTH OAKS

SHOREVIEW

VADNAIS HEIGHTS

ARDEN HILLS

LEXINGTON AVENUE

RICE STREET

LINE

COUNTY ROAD F

13 14 15 18 19 23 24

water

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RAMSEY COUNTY, MINNESOTA NO. 6

WASHINGTON COUNTY, MINNESOTA NO. 7
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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

7

N

1 Mile

5 000 Feet

Scale 1:15 840

RAMSEY COUNTY, MINNESOTA NO. 7

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

7

N

1 Mile

5 000 Feet

Scale 1:15 840

2 240 000 FEET

760 000 FEET

T. 30 N.

R. 22 W.

1055

(Joins sheet 3)

(Joins sheet 6)

(Joins inset, sheet 4)

2 250 000 FEET

(Joins sheet 10)

755 000 FEET

NORTH OAKS

GILFILLAN LAKE

BIRCH LAKE

WHITE BEAR LAKE

VADNAIS HEIGHTS

Goose Lake

White Bear Lake

COUNTY ROAD F

WHITE BEAR AVE

BURLINGTON NORTHERN

UNION CEM

SOO LINE

water

17

16

15

14

20

21

22

23

8

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

R. 20 W. | R. 19 W.

2 325 000 FEET

825 000 FEET

T. 32 N.

820 000 FEET

2 310 000 FEET

(Joins sheet 4)

(Joins sheet 7)

(Joins sheet 12)

WISCONSIN

POLK COUNTY

RIVER

SAINT CROIX

LINE

Scandia

Otisville

water

13 14 18 19 23 24

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WASHINGTON COUNTY, MINNESOTA NO. 8

8

N

1 Mile

5 000 Feet

0

Scale 1:15 840

¼ 1 000

2 000

½ 3 000

¾ 4 000

1 5 000

(Joins sheet 5)

R. 23 W.

2 215 000 FEET

750 000 FEET

T. 30 N.

745 000 FEET

860C

2 200 000 FEET

ANOKA COUNTY

HENNEPIN COUNTY

(Joins sheet 12)

(Joins sheet 9)

NEW BRIGHTON

SAINT ANTHONY

ARDEN HILLS

LAKE JOHANNA

Valentine Lake

Silver Lake

Poplar Lake

Lake Jones

Little Johanna Lake

Lake Josephine

30

29

28

27

31

32

33

34

COUNTY ROAD E

COUNTY ROAD D

SOO LINE

MINNESOTA TRANSFER

MINNESOTA

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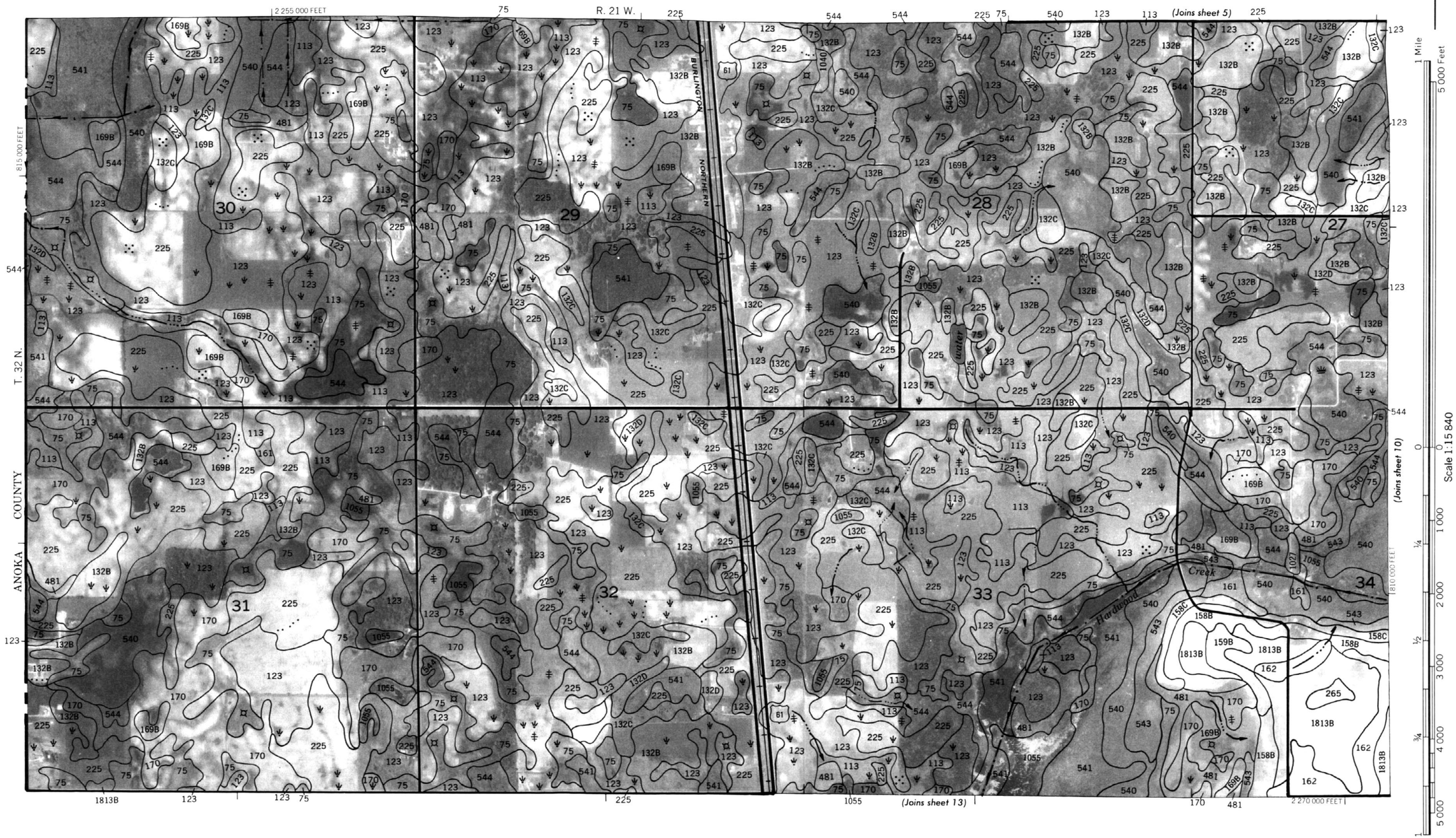
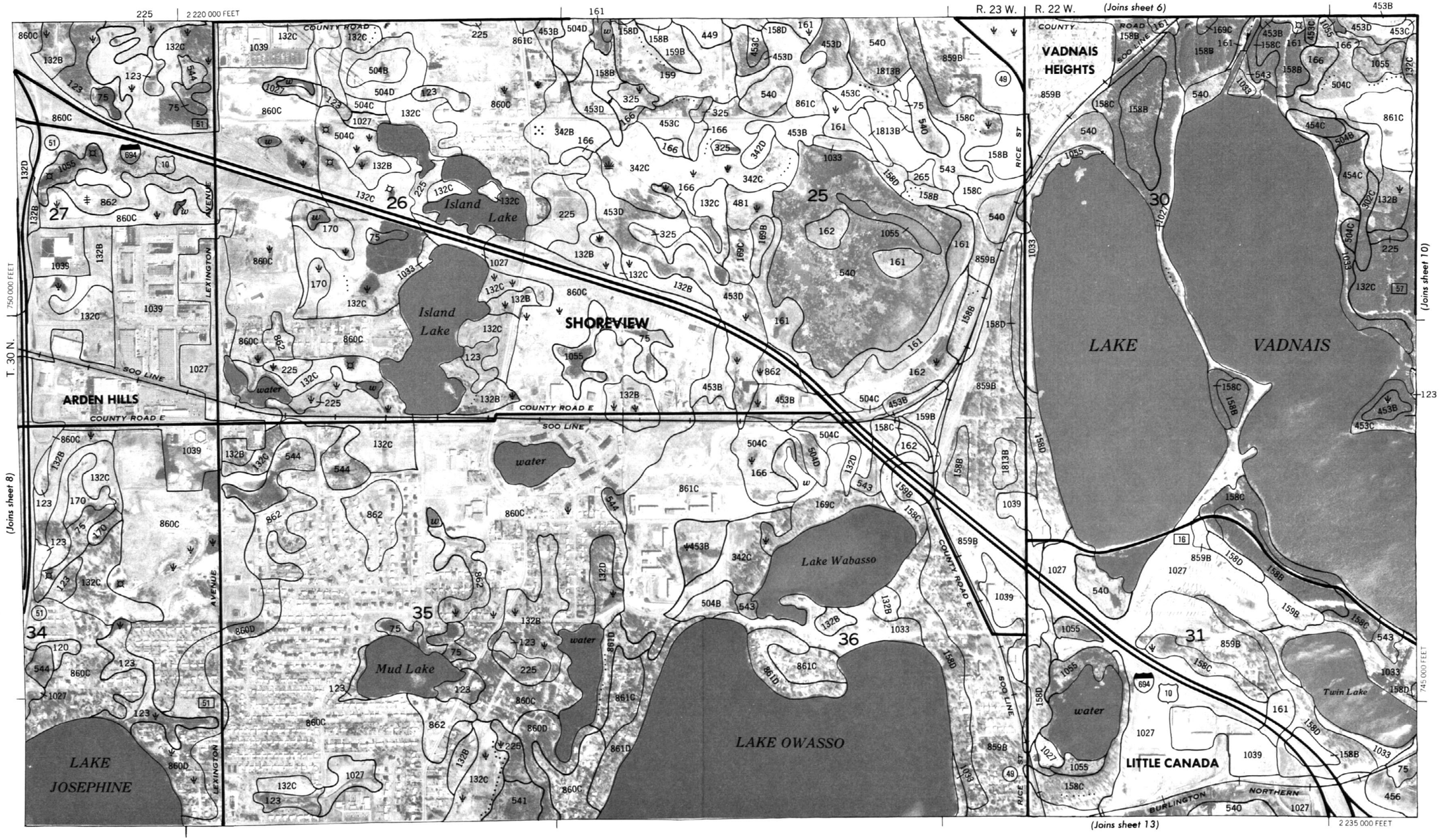
RAMSEY COUNTY, MINNESOTA NO. 8


2 255 000 FEET
R. 21 W.
(Joins sheet 5)
815 000 FEET
T. 32 N.
ANOKA COUNTY
BURLINGTON NORTHERN
30
29
28
27
31
32
33
34
water
Hardwood Creek
(Joins sheet 10)
(Joins sheet 13)
2 270 000 FEET
810 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840


225
2 220 000 FEET
161
R. 23 W.
R. 22 W.
(Joins sheet 6)
453B
T. 30 N.
750 000 FEET
(Joins sheet 8)
ARDEN HILLS
SHOREVIEW
VADNAIS HEIGHTS
LAKE VADNAIS
LAKE JOSEPHINE
LAKE OWASSO
LITTLE CANADA
Island Lake
Mud Lake
Lake Wabasso
Twin Lake
water
COUNTY ROAD F
COUNTY ROAD E
SOO LINE
LEXINGTON AVENUE
RICE ST
COUNTY ROAD E
BURLINGTON NORTHERN
(Joins sheet 10)
(Joins sheet 13)
2 235 000 FEET
745 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840

10

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

R. 21 W. | R. 20 W.

T. 32 N.

2 285 000 FEET

815 000 FEET

810 000 FEET

2 275 000 FEET

(Joins sheet 6)

(Joins sheet 9)

(Joins sheet 11)

(Joins sheet 14)

27 26 25 30 35 36 34 31

Hardwood Creek

White Rock Lake

Big Marine Lake

water

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA — SHEET NO. 10

N

1 Mile
5 000 Feet

Scale 1:15 840

0 0
¼ 1 000
½ 2 000
¾ 3 000
1 4 000
5 000

504C 453C 860C 158B 169C

(Joins sheet 7)

R. 22 W.

2 250 000 FEET

2 240 000 FEET

(Joins sheet 14)

(Joins sheet 9)

745 000 FEET

750 000 FEET

T. 30 N.

(Joins sheet 11)

COUNTY ROAD E

VADNAIS HEIGHTS

WHITE BEAR LAKE

LAKE VADNAIS

Gem Lake

Willow Lake

water

BURLINGTON NORTHERN

WHITE BEAR AVENUE

29 28 27 26 32 33 34 35

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, MINNESOTA NO. 10

WASHINGTON COUNTY, MINNESOTA NO. 11

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

11

N

1 Mile

5 000 Feet

Scale 1:15 840

2 290 000 FEET

815 000 FEET

R. 20 W.

T. 32 N.

(Joins sheet 7)

(Joins sheet 10)

(Joins sheet 12)

(Joins sheet 15)

2 305 000 FEET

810 000 FEET

Fish Lake

Hay Lake

Sand Lake

Long Lake

BIG MARINE LAKE

water

29

28

27

26

33

34

35

RAMSEY COUNTY, MINNESOTA NO. 11

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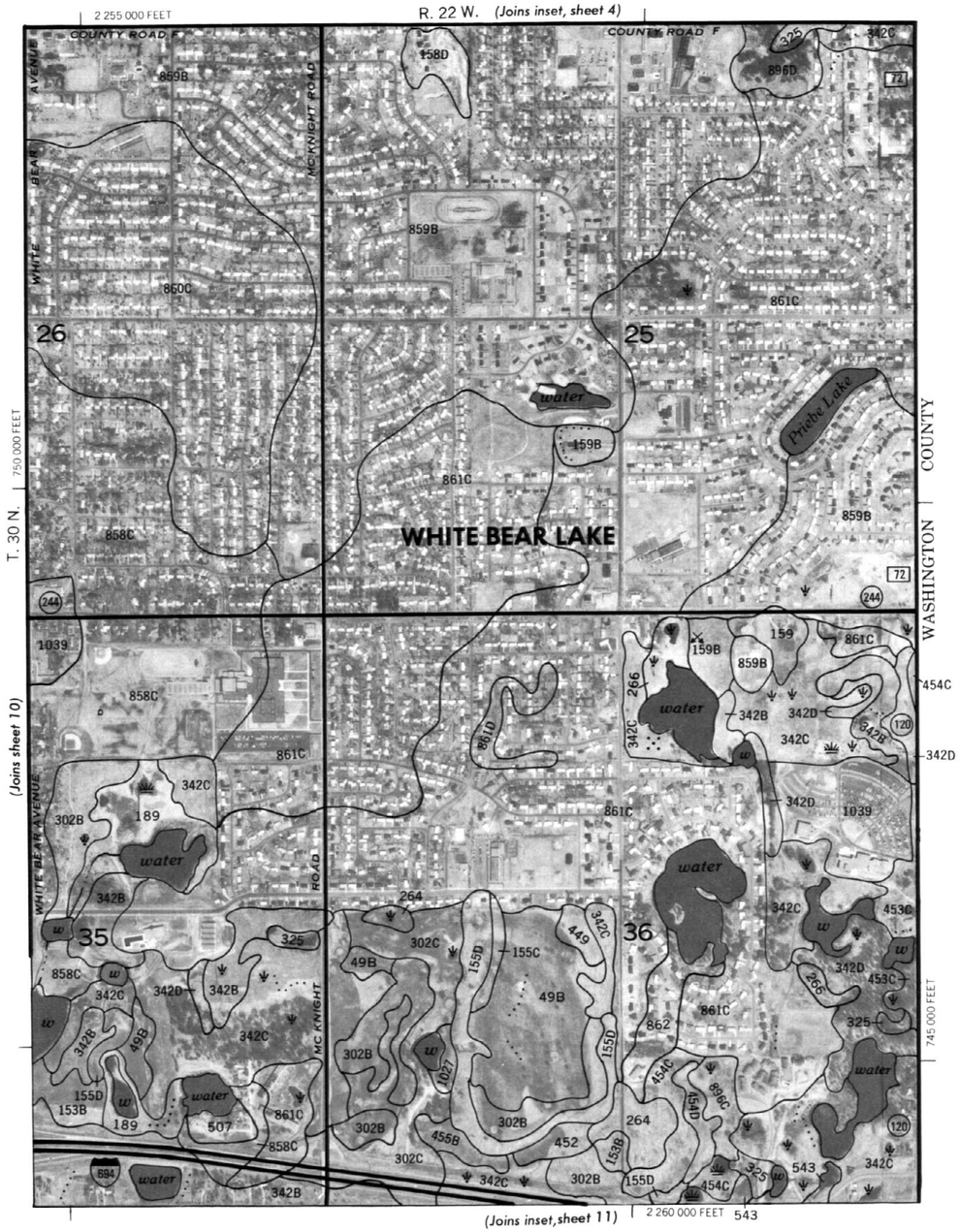
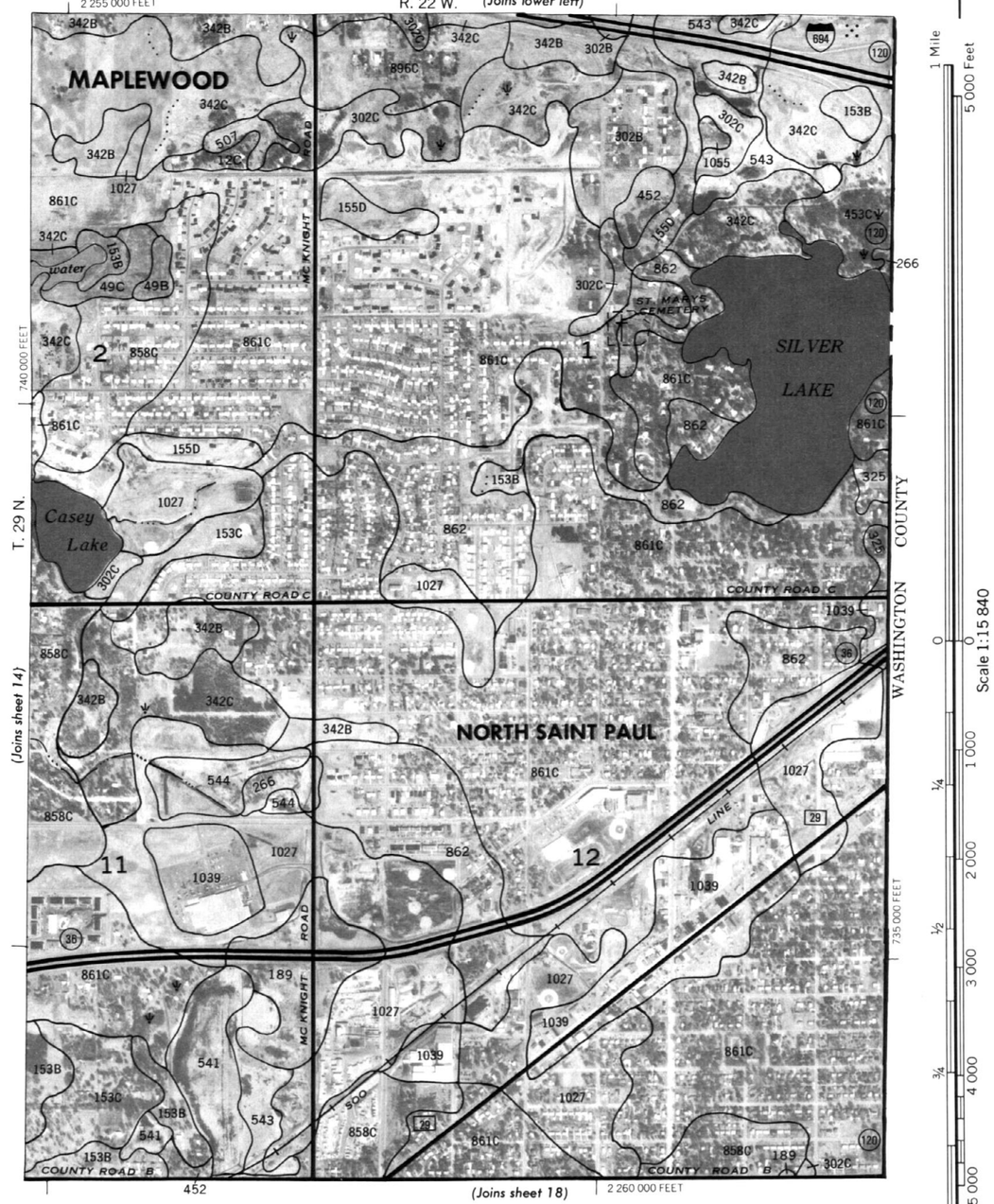




12

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

R. 20 W. | R. 19 W.

2 325 000 FEET

815 000 FEET

T. 32 N.

810 000 FEET

2 310 000 FEET

(Joins sheet 8)

(Joins sheet 11)

(Joins sheet 16)

Sand Lake

WILLIAM O'BRIEN STATE PARK

STATE PARK BOUNDARY

SAINT CROIX COUNTY

POLK COUNTY

WISCONSIN RIVER

Copas

water

26 25 30 35 36 31

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and tie points are shown. Corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 12

12

N

1 Mile

5 000 Feet

0 0

Scale 1:15 840

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

R. 23 W. (Joins sheet 8)

2 215 000 FEET

740 000 FEET

T. 29 N.

735 000 FEET

2 205 000 FEET

(Joins sheet 13)

(Joins sheet 15)

COUNTY ROAD D

COUNTY ROAD C

COUNTY ROAD B

HENNEPIN COUNTY

TRANSFER

BURLINGTON NORTHERN

MINNESOTA

SNELLING AVENUE

CO RD C

ROSEVILLE

Little Johanna Lake

Langton Lake

water

5

4

3

8

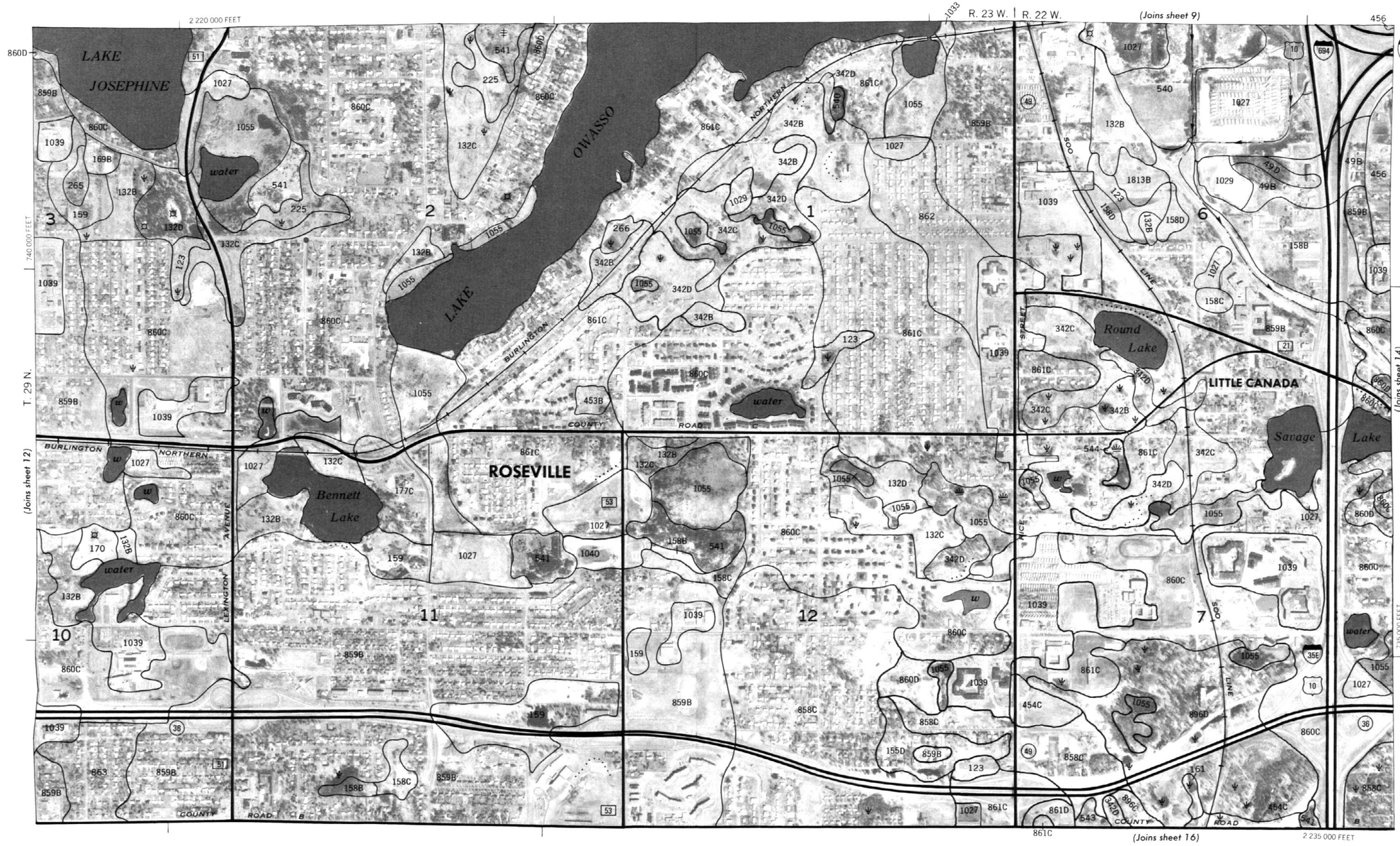
9

10

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, MINNESOTA NO. 12

R. 21 W.
T. 31 N.
COUNTY
ANOKA
2 255 000 FEET
2 270 000 FEET
805 000 FEET
800 000 FEET
(Joins sheet 9)
(Joins sheet 14)
(Joins sheet 17)
Hardwood Creek
Horseshoe Lake
water
Oneka Lake
Weston
NORTHERN
BURLINGTON
1 Mile
5 000 Feet
Scale 1:15 840


13
N
2 220 000 FEET
R. 23 W.
R. 22 W.
(Joins sheet 9)
456
1033
860D
LAKE JOSEPHINE
OWASSO
LAKE
water
NORTHERN
BURLINGTON
740 000 FEET
T. 29 N.
(Joins sheet 12)
ROSEVILLE
Bennett Lake
Round Lake
Savage Lake
LITTLE CANADA
LEXINGTON AVENUE
SOO LINE
COUNTY ROAD B
COUNTY ROAD C
(Joins sheet 16)
2 235 000 FEET
735 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840

14

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0

¼ 1 000

½ 2 000

¾ 4 000

1 5 000

R. 21 W. | R. 20 W.

T. 31 N.

2 285 000 FEET

805 000 FEET

800 000 FEET

2 275 000 FEET

(Joins sheet 10)

(Joins sheet 13)

(Joins sheet 15)

(Joins sheet 18)

Hardwood Creek

Barker Lake

Mud Lake

water

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 14

(14)

N

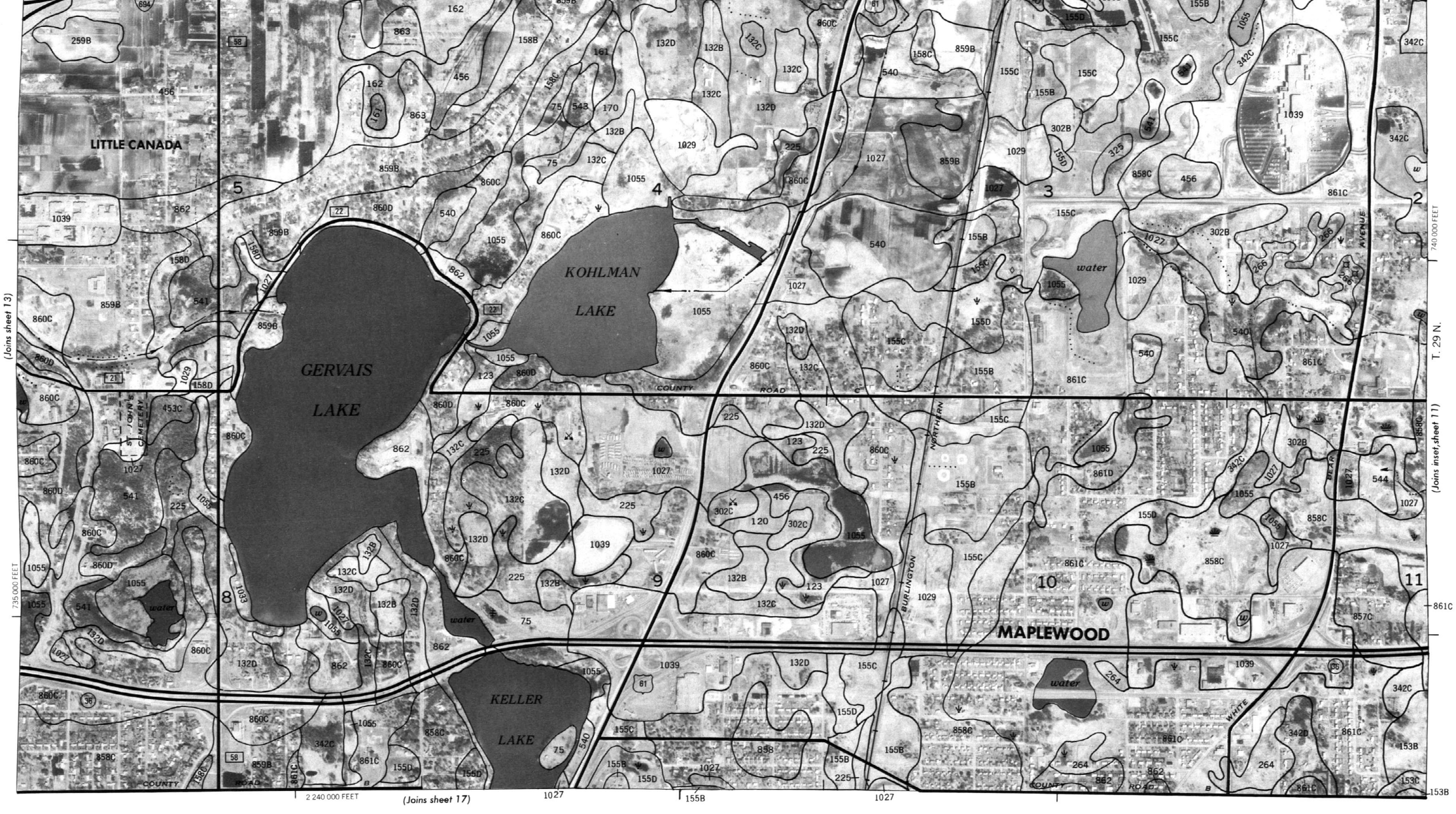
1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, MINNESOTA NO. 14

WASHINGTON COUNTY, MINNESOTA NO. 15
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

15

N

2 290 000 FEET

R. 20 W.

(Joins sheet 11)

805 000 FEET

T. 31 N.

(Joins sheet 14)

(Joins sheet 16)

800 000 FEET

(Joins sheet 19)

2 305 000 FEET

BIG MARINE LAKE

Long Lake

Staples Lake

Mud Lake

Terrapin Lake

1 Mile

5 000 Feet

Scale 1:15 840

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

2 205 000 FEET

R. 23 W.

(Joins sheet 12)

730 000 FEET

COUNTY ROAD B

ROSEVILLE

SNELLING AVE

LAUDERDALE

COUNTY T. 29 N.

HENNEPIN

TRANSFER

LARPENTEUR AVENUE

COMO AVENUE

FALCON HEIGHTS

UNIVERSITY OF MINNESOTA ST. PAUL CAMPUS

MINNESOTA STATE FAIRGROUND

MINNESOTA

17

16

15

20

21

22

(Joins sheet 16)

(Joins sheet 19)

725 000 FEET

2 215 000 FEET

15

N

1 Mile

5 000 Feet

Scale 1:15 840

16

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 12)

R. 20 W. | R. 19 W.

329

2 325 000 FEET

805 000 FEET

T. 31 N.

(Joins sheet 15)

800 000 FEET

2 310 000 FEET

(Joins sheet 20)

Marine on St Croix

OAKLAND CEMETERY

SOO LINE

SAINT CROIX — ST. CROIX COUNTY, WISCONSIN

RIVER

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 16

16

N

1 Mile 5 000 Feet

Scale 1:15 840

R. 23 W. | R. 22 W.

T. 29 N.

(Joins sheet 13)

(Joins sheet 15)

(Joins sheet 17)

(Joins sheet 20)

2 235 000 FEET

730 000 FEET

725 000 FEET

2 220 000 FEET

ROSEVILLE

SAINT PAUL
(County Seat)

MAPLEWOOD

McCarrons Lake

LAKE COMO

water

ROSELAWN CEMETERY

TEMPLE OF AARON CEMETERY

ELMHURST CEMETERY

MC CARRONS LAKE FILTRATION PLANT

15 14 13 18 22 23 24 19

COUNTY ROAD B

LARPENTEUR AVENUE

LEXINGTON AVENUE

RICE STREET

MARYLAND AVENUE

NORTHERN PACIFIC LINE

BURLINGTON NORTHERN

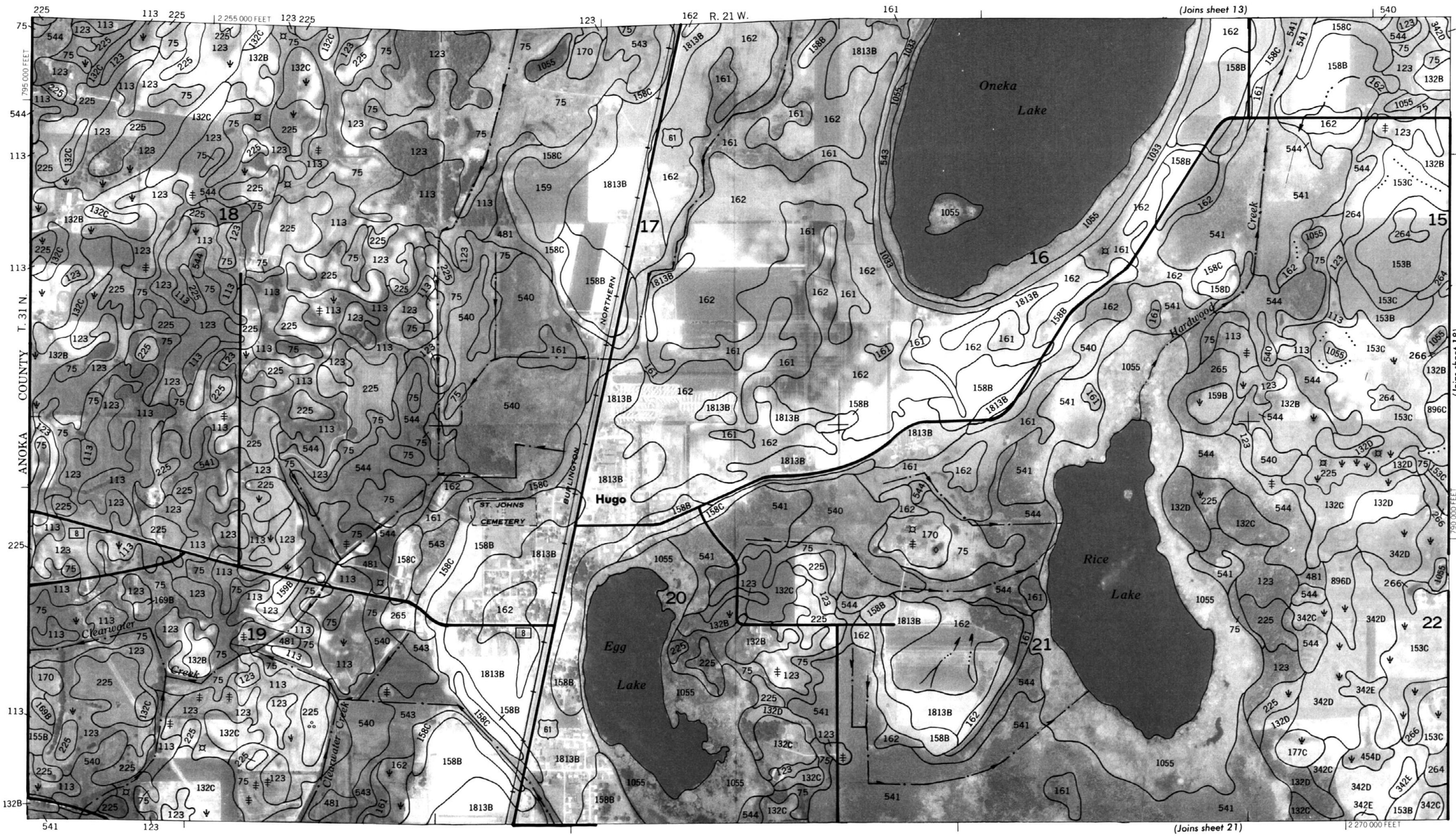
SOO LINE

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, MINNESOTA NO. 16

WASHINGTON COUNTY, MINNESOTA NO. 17

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



17

N

1 Mile

5 000 Feet

Scale 1:15 840

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

2 240 000 FEET

R. 22 W.

(Joins sheet 14)

730 000 FEET

T. 29 N.

(Joins sheet 16)

(Joins sheet 18)

725 000 FEET

2 250 000 FEET

(Joins sheet 21)

KELLER LAKE

Round Lake

LAKE PHALEN

Wakefield Lake

Frost Lake

MAPLEWOOD

SAINT PAUL
(County Seat)

17 16 15 14 20 21 22 23

FOREST LAWN CEMETERY

MT. ZION CEMETERY

CHESED SHEL EMES CEMETERY

COUNTY ROAD B

LARPENTEUR AVENUE

MARYLAND AVENUE

NORTHERN PACIFIC

SOO LINE

BURLINGTON NORTHERN

BEAR

WHITE

17

N

1 Mile

5 000 Feet

Scale 1:15 840

18

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

790 000 FEET

R. 21 W. | R. 20 W.

2 285 000 FEET

795 000 FEET

T. 31 N.

(Joins sheet 14)

(Joins sheet 17)

(Joins sheet 19)

(Joins sheet 22)

2 275 000 FEET

15 14 13 18 22 23 24 19

water

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

MINNESOTA NO. 18

WASHINGTON COUNTY, MINNESOTA

18

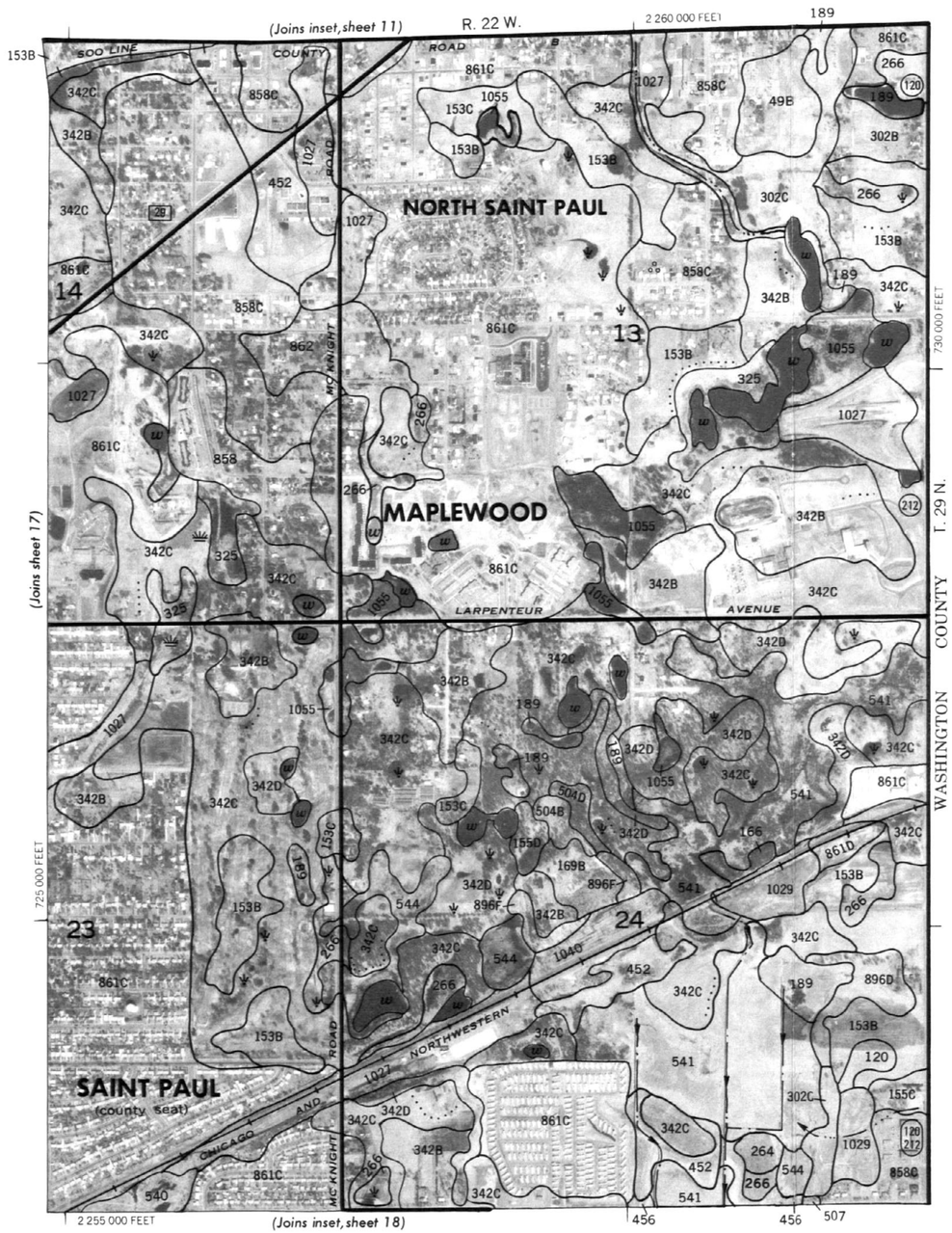
N

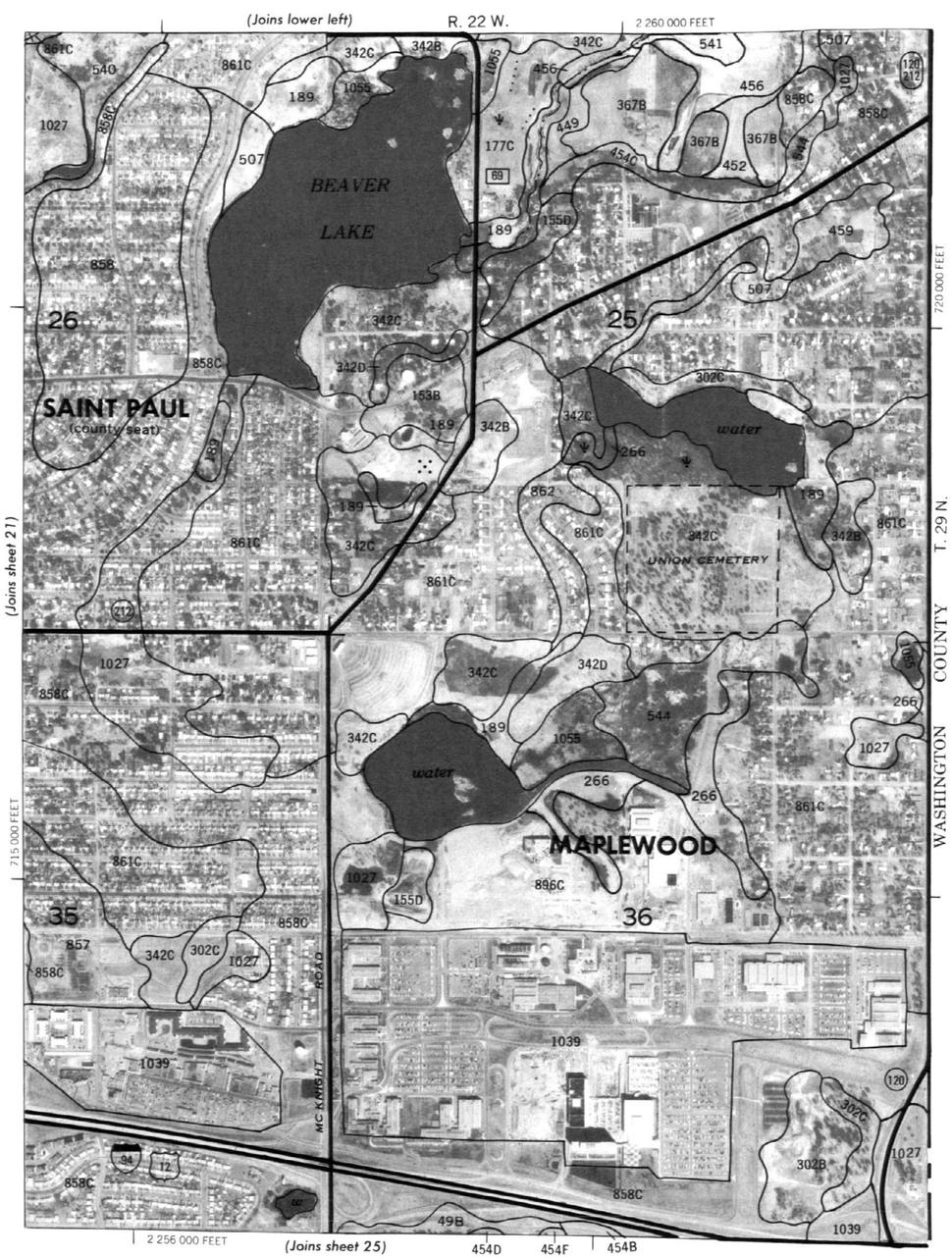
1 Mile

5 000 Feet

Scale 1:15 840

1 5 000 — ¾ 4 000 — ½ 3 000 — ¼ 2 000 — 0 1 000 — 0





4000 AND 5000-FOOT GRID TICKS

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, MINNESOTA NO. 18

N

WASHINGTON COUNTY, MINNESOTA NO. 19

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

2 290 000 FEET

795 000 FEET

R. 20 W.

T. 31 N.

(Joins sheet 15)

(Joins sheet 18)

(Joins sheet 20)

(Joins sheet 23)

2 305 000 FEET

790 000 FEET

Mud Lake

Turtle Lake

Maple Island

Bass Lake

West Boot Lake

East Boot Lake

Terrapin Lake

Mays Lake

Clear Lake

Square Lake

15

16

17

20

21

22

23

14

1 Mile

5 000 Feet

Scale 1:15 840

RAMSEY COUNTY, MINNESOTA NO. 19

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

19

N

2 205 000 FEET

R. 23 W.

(Joins sheet 15)

720 000 FEET

COMO AVENUE

BURLINGTON NORTHERN

water

MINNESOTA TRANSFER

UNIVERSITY AVENUE

SAINT PAUL
(County Seat)

HENNEPIN COUNTY

T. 29 N.

MISSISSIPPI RIVER

CHICAGO MILWAUKEE ST. PAUL AND PACIFIC

SNELLING AVENUE

29

28

27

32

33

34

(Joins sheet 20)

(Joins sheet 22)

715 000 FEET

2 215 000 FEET

1 Mile

5 000 Feet

Scale 1:15 840

20

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

R. 20 W. | R. 19 W

T. 31 N

2 325 000 FEET

795 000 FEET

790 000 FEET

2 310 000 FEET

(Joins sheet 16)

(Joins sheet 19)

(Joins sheet 24)

SAINT CROIX RIVER

WISCONSIN

ST. CROIX COUNTY

Square Lake

13 14 18 19 23 24

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 20

20

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 16)

R. 23 W.

R. 22 W.

2 235 000 FEET

720 000 FEET

T. 29 N.

715 000 FEET

2 220 000 FEET

(Joins sheet 19)

(Joins sheet 21)

(Joins sheet 23)

LAKE COMO

water

SAINT PAUL
(County Seat)

MINNESOTA STATE CAPITOL

CALVARY CEMETERY

OAKLAND CEMETERY

MARYLAND AVENUE

COMO AVENUE

BURLINGTON NORTHERN

SOO LINE

RICE STREET

LEXINGTON PARKWAY

UNIVERSITY AVENUE

27 26 25 30 34 35 36 31

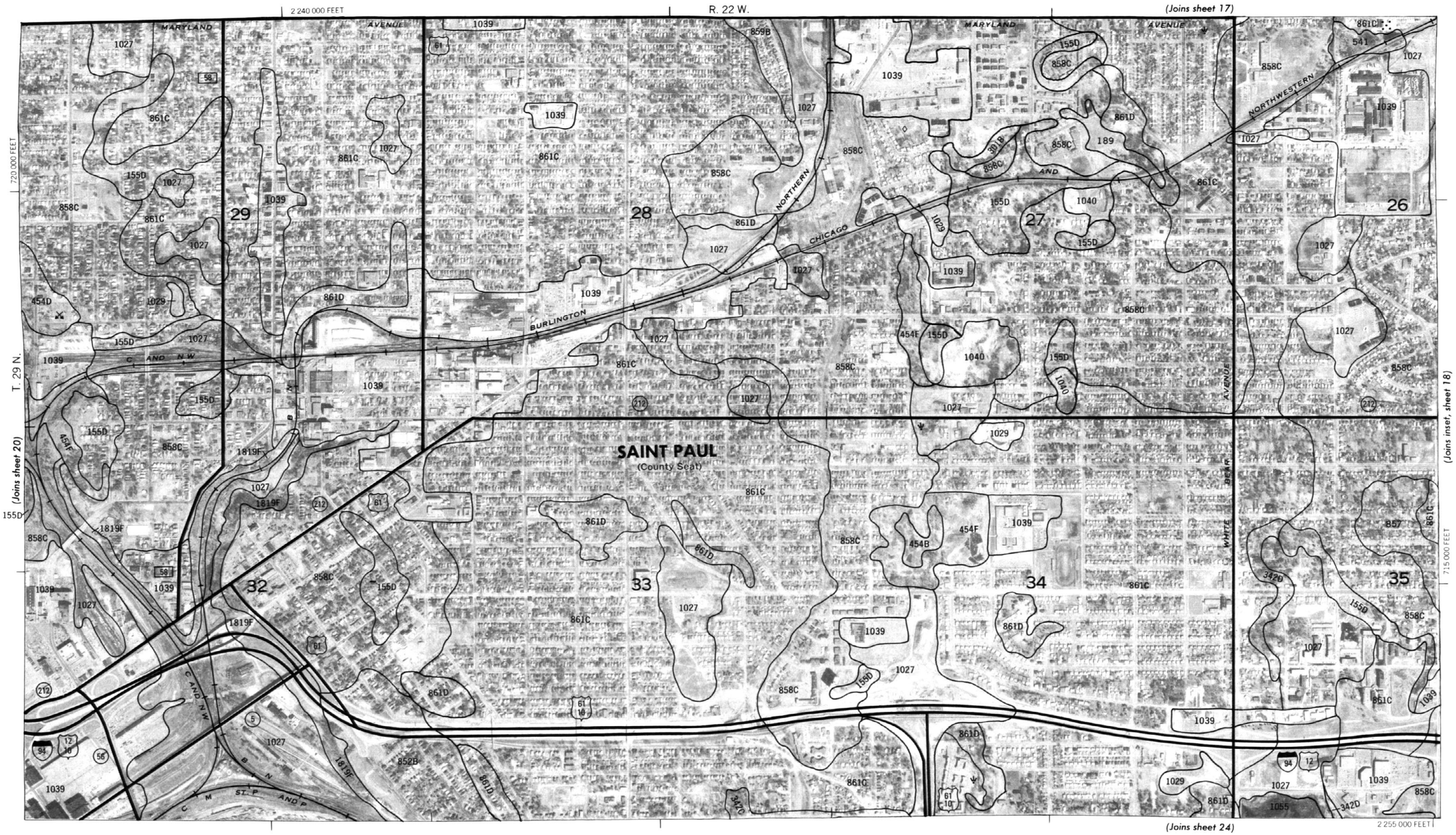
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, MINNESOTA NO. 20

WASHINGTON COUNTY, MINNESOTA NO. 21

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, MINNESOTA NO. 21
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agenc
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



21

N

1 Mile

5 000 Feet

Scale 1:15 840

1 0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

22

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

153C (Joins sheet 18) | R. 21 W. | R. 20 W | 2 285 000 FEET | 785 000 FEET | T. 31 N.

(Joins sheet 21) | (Joins sheet 23)

780 000 FEET | 2 275 000 FEET

504C (Joins 25) | (Joins sheet 26)

North School Section Lake | Lake Plaisted | South School Section Lake | Lynch Lake | Sunset Lake | Long Lake | Round Lake | Goggins Lake

26 | 25 | 27 | 30 | 35 | 36 | 34 | 31

WITHROW CEMETERY

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 22

22

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 23 W.

(Joins sheet 19)

2 215 000 FEET

710 000 FEET

705 000 FEET

2 205 000 FEET

T. 28 N.

(Joins sheet 23)

(Joins sheet 26)

HENNEPIN COUNTY

RAMSEY COUNTY

MISSISSIPPI RIVER

SAINT PAUL
(County Seat)

SNELLING AVENUE

C M ST P AND P

1 2 3 4 5 6 7 8 9 10

1027 1819F 858C 155D 120 857 857C 1039 212 51 860D 860C 862 411C 1328 123 75 858G 861C

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, MINNESOTA NO. 22

WASHINGTON COUNTY, MINNESOTA NO. 23

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, MINNESOTA NO. 23
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land divisions corners, if shown, are approximately positioned

2 220 000 FEET

R. 23 W. | R. 22 W.

(Joins sheet 20)

710 000 FEET

T. 28 N.

(Joins sheet 22)

(Joins sheet 24)

705 000 FEET

(Joins sheet 27)

DAKOTA COUNTY

2 235 000 FEET

SAINT PAUL
(County Seat)

MISSISSIPPI RIVER

HARRIET ISLAND

DAKOTA COUNTY

CHICAGO MILWAUKEE ST. PAUL AND PACIFIC ROAD

CHICAGO AND NORTHWESTERN

SHEPARD

PARKWAY

LEXINGTON

1 Mile
5 000 Feet

Scale 1:15 840

24

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 20 W. | R. 19 W.

2 325 000 FEET

785 000 FEET

780 000 FEET

2 310 000 FEET

T. 31 N.

(Joins sheet 20)

(Joins sheet 23)

(Joins 27)

(Joins sheet 28)

Square Lake

Big Carnelian Lake

Twin Lakes

Arcola

SAINT CROIX COUNTY

ST. CROIX RIVER

WISCONSIN

SOO LINE

water

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 24

24

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0

¼ 1 000

½ 2 000

¾ 4 000

1 5 000

R. 22 W.

2 255 000 FEET

710 000 FEET

705 000 FEET

2 240 000 FEET

T. 28 N.

(Joins sheet 21)

(Joins sheet 23)

(Joins sheet 25)

(Joins inset sheet 27)

MISSISSIPPI RIVER

SAINT PAUL
(County Seat)

SAINT PAUL DOWNTOWN AIRPORT
HOLMAN FIELD

PIGS EYE ISLAND SANITARY LANDFILL

METROPOLITAN WASTEWATER TREATMENT PLANT

PIGS EYE LAKE

water

RIVERVIEW CEMETERY

Battle

DAKOTA COUNTY

PIGS EYE ISLAND NO 1

RAMSEY COUNTY, MINNESOTA NO. 24

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 25

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

25

N

2 255 000 FEET

775 000 FEET

R. 21 W.

(Joins sheet 21) | (Joins sh. 22)

T. 30 N.

RAMSEY COUNTY

Fish Lake

Dellwood

Pine Tree Lake

White Bear Lake

(Joins sheet 26)

(Joins sheet 29)

765 000 FEET

2 270 000 FEET

1 Mile

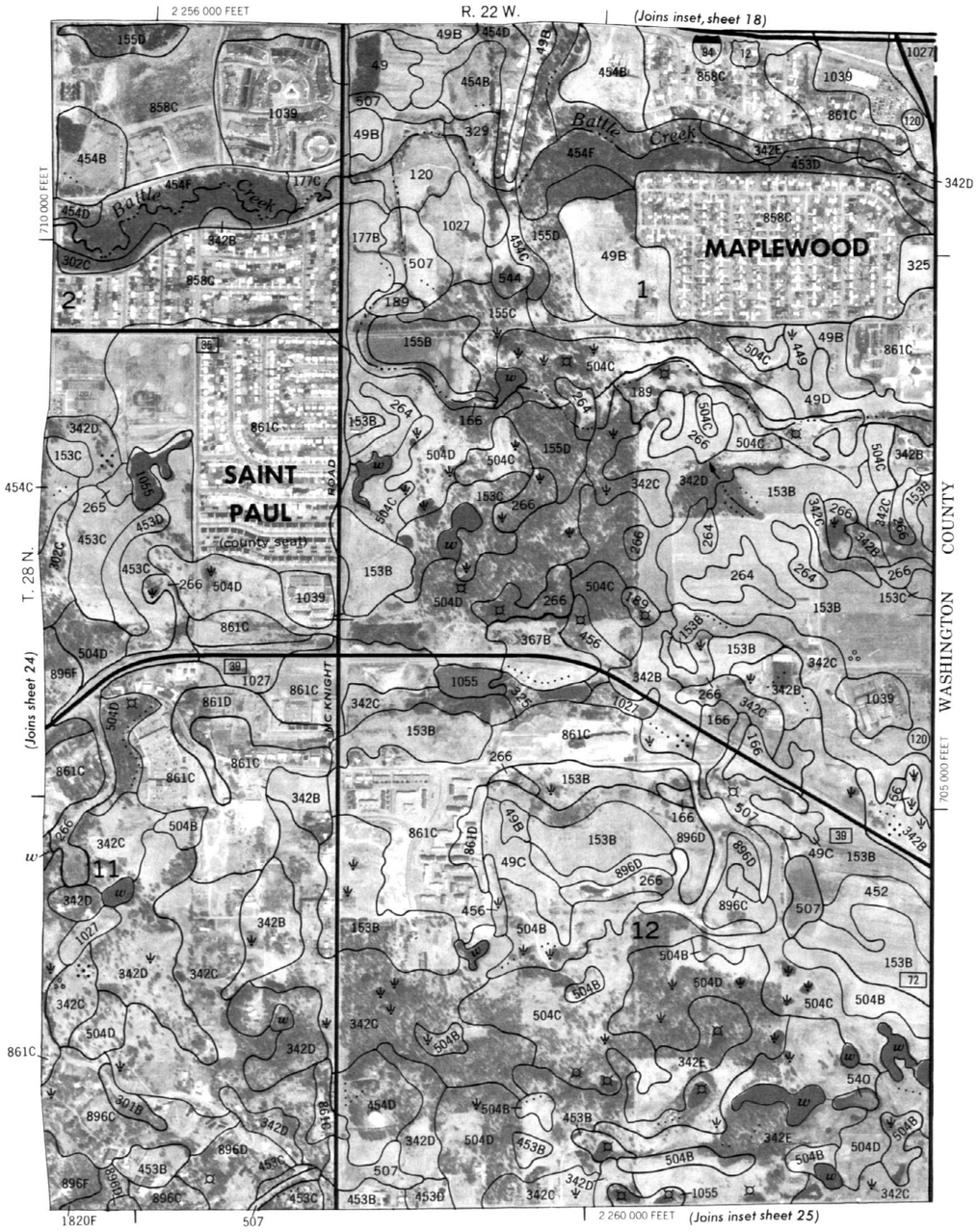
5 000 Feet

Scale 1:15 840

RAMSEY COUNTY, MINNESOTA NO. 25

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

Coordinate grid ticks and land division corners, if shown, are approximately positioned.



4000 AND 5000-FOOT GRID TICKS

4000 AND 5000-FOOT GRID TICKS

1 Mile
5 000 Feet
Scale 1:15 840

26

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 21 W.

T. 30 N.

(Joins sheet 22) | (Joins 23)

2 290 000 FEET

775 000 FEET

(Joins sheet 25)

(Joins sheet 27)

(Joins sheet 30)

2 275 000 FEET

765 000 FEET

Withrow

Mann Lake

Benz Lake

Pat Lake

water

LINE

SOO LINE

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 26

(26)

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0 ¼ 1 000 ½ 2 000 ¾ 4 000 1 5 000

R. 23 W. (Joins sheet 22) 2 215 000 FEET 700 000 FEET

695 000 FEET

T. 28 N.

FORD BRIDGE

LOCK AND DAM NO. 1

HENNEPIN COUNTY

MISSISSIPPI RIVER

SNELLING AVENUE

SAINT PAUL
(county seat)

CHICAGO MILWAUKEE ST. PAUL AND PACIFIC

SHEPARD ROAD

FORT SNELLING STATE HISTORICAL PARK

Pike Island

MINNESOTA R.

DAKOTA CO.

(Joins sheet 27)

(Joins inset sheet 26)

R. 23 W. (Joins lower right) 2 217 000 FEET

689 000 FEET

690 000 FEET

T. 28 N.

Pike Island

FORT SNELLING STATE HISTORICAL PARK

HENN. CO.

DAKOTA COUNTY

MINNESOTA RIVER

2 215 000 FEET

1000 AND 2000-FOOT GRID TICKS

2 205 000 FEET

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, MINNESOTA NO. 26

WASHINGTON COUNTY, MINNESOTA NO. 27

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

R. 21 W. | R. 20 W.

2 295 000 FEET

775 000 FEET

T. 30 N.

Louise Lake

Loon Lake

Silver Lake

water

Silver Creek

(Joins sheet 23) | (Joins 24)

(Joins sheet 26)

(Joins sheet 28)

(Joins sheet 31)

2 305 000 FEET

770 000 FEET

27

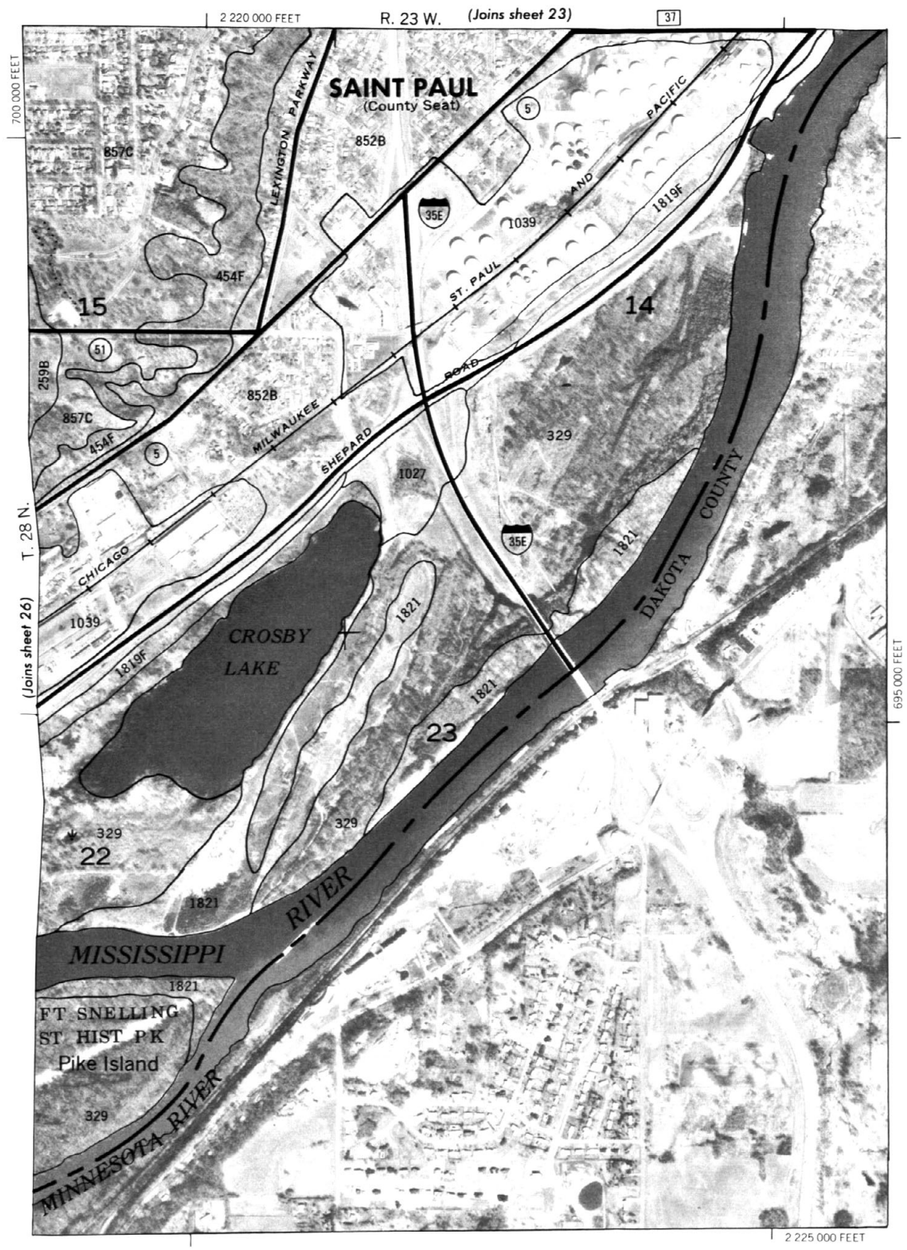
N

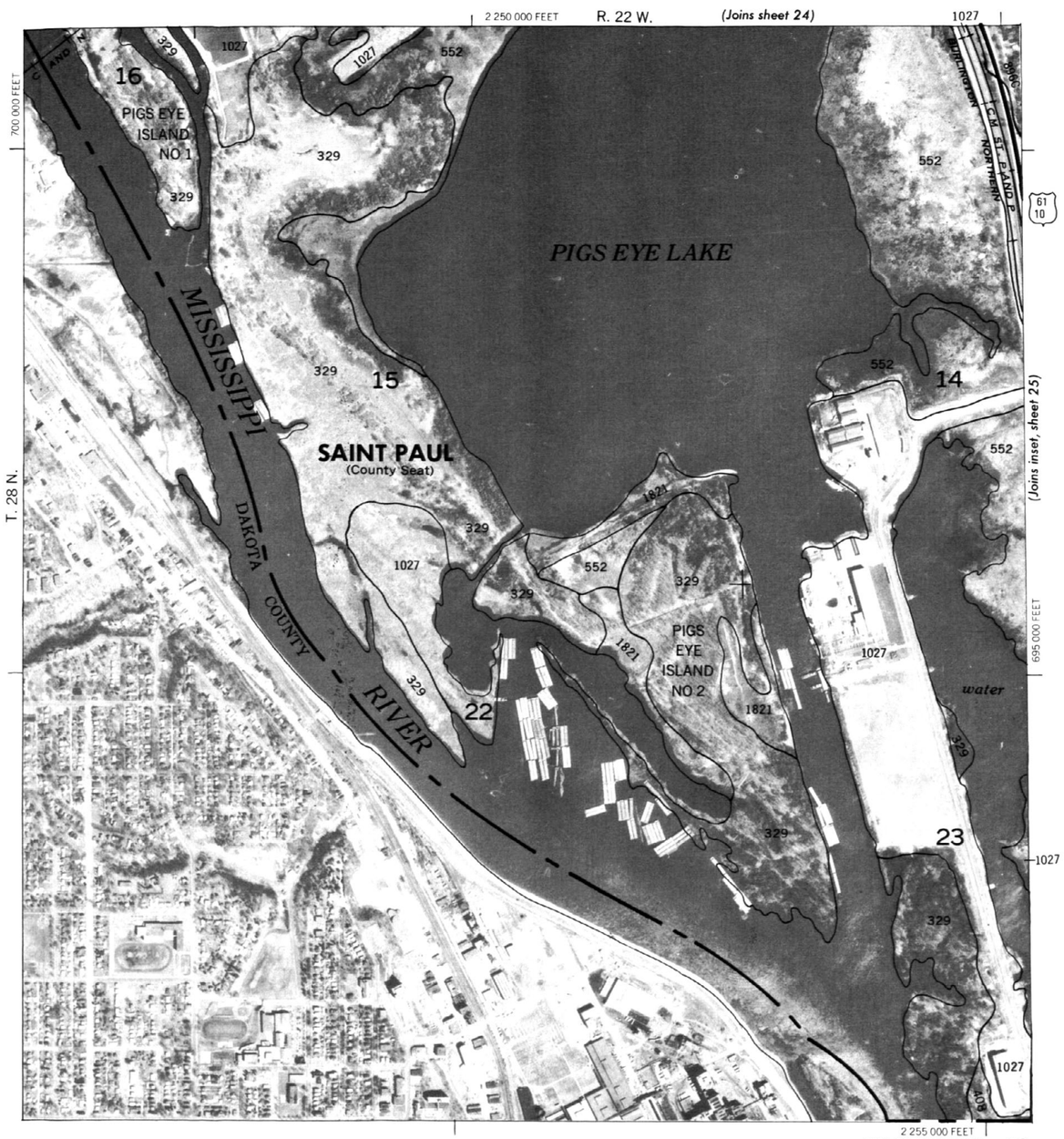
1 Mile

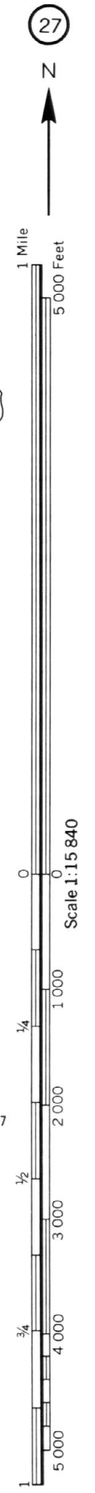
5 000 Feet

Scale 1:15 840

RAMSEY COUNTY, MINNESOTA NO. 27
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned







28

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

770 000 FEET

775 000 FEET

2 310 000 FEET

2 325 000 FEET

R. 20 W.

T. 30 N.

(Joins sheet 24)

(Joins sheet 27)

(Joins sheet 32)

Little Carnelian Lake

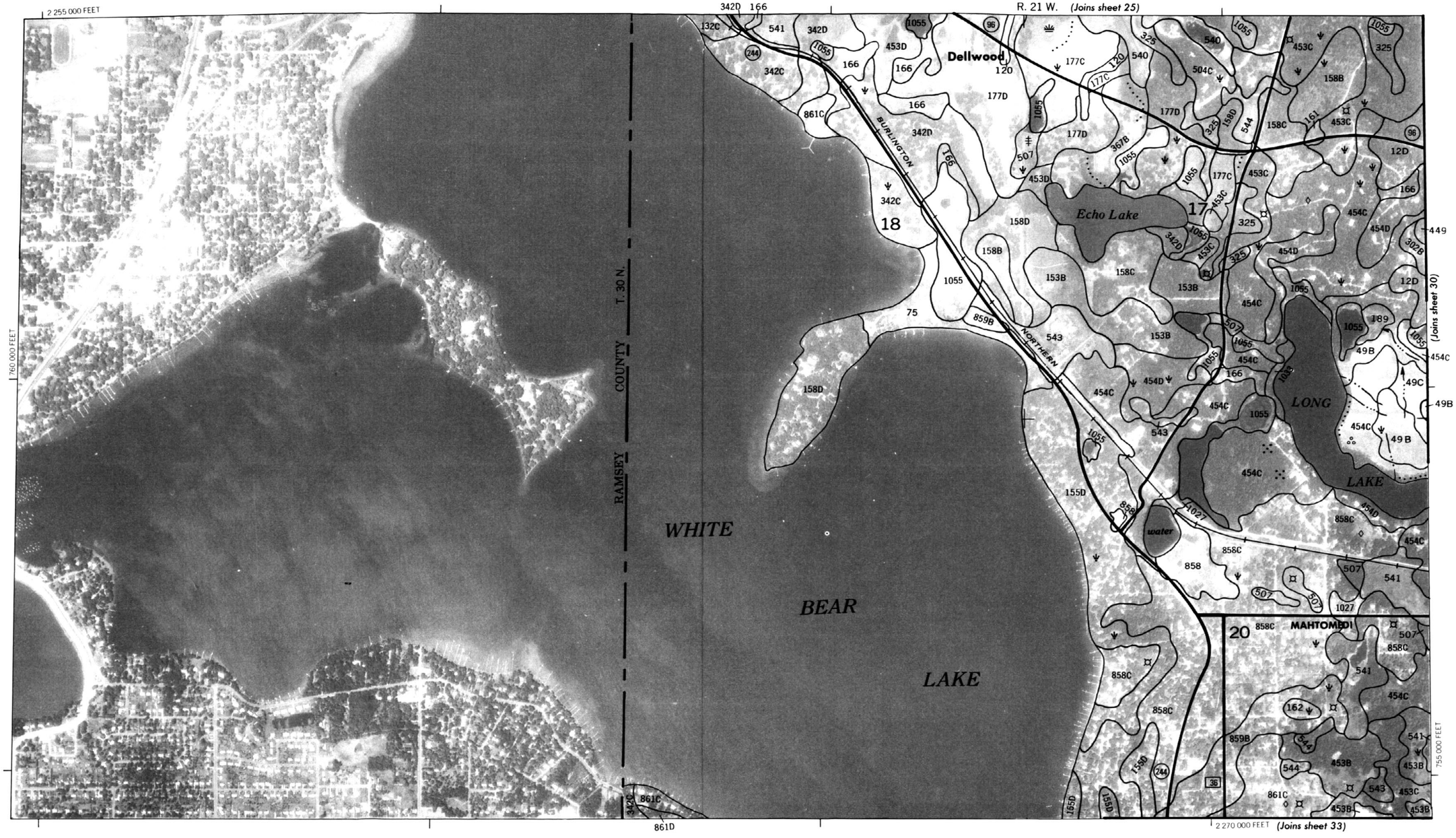
WISCONSIN

SAINT CROIX RIVER

ST CROIX COUNTY

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 28


29
N
2 255 000 FEET
760 000 FEET
R. 21 W. (Joins sheet 25)
T. 30 N.
RAMSEY COUNTY
WHITE
BEAR
LAKE
Dellwood
Echo Lake
LONG
LAKE
water
MAHTOMEDI
BURLINGTON
NORTHERN
17
18
20
(Joins sheet 30)
2 270 000 FEET (Joins sheet 33)
755 000 FEET
861D
1 Mile
5 000 Feet
Scale 1:15 840

30

N

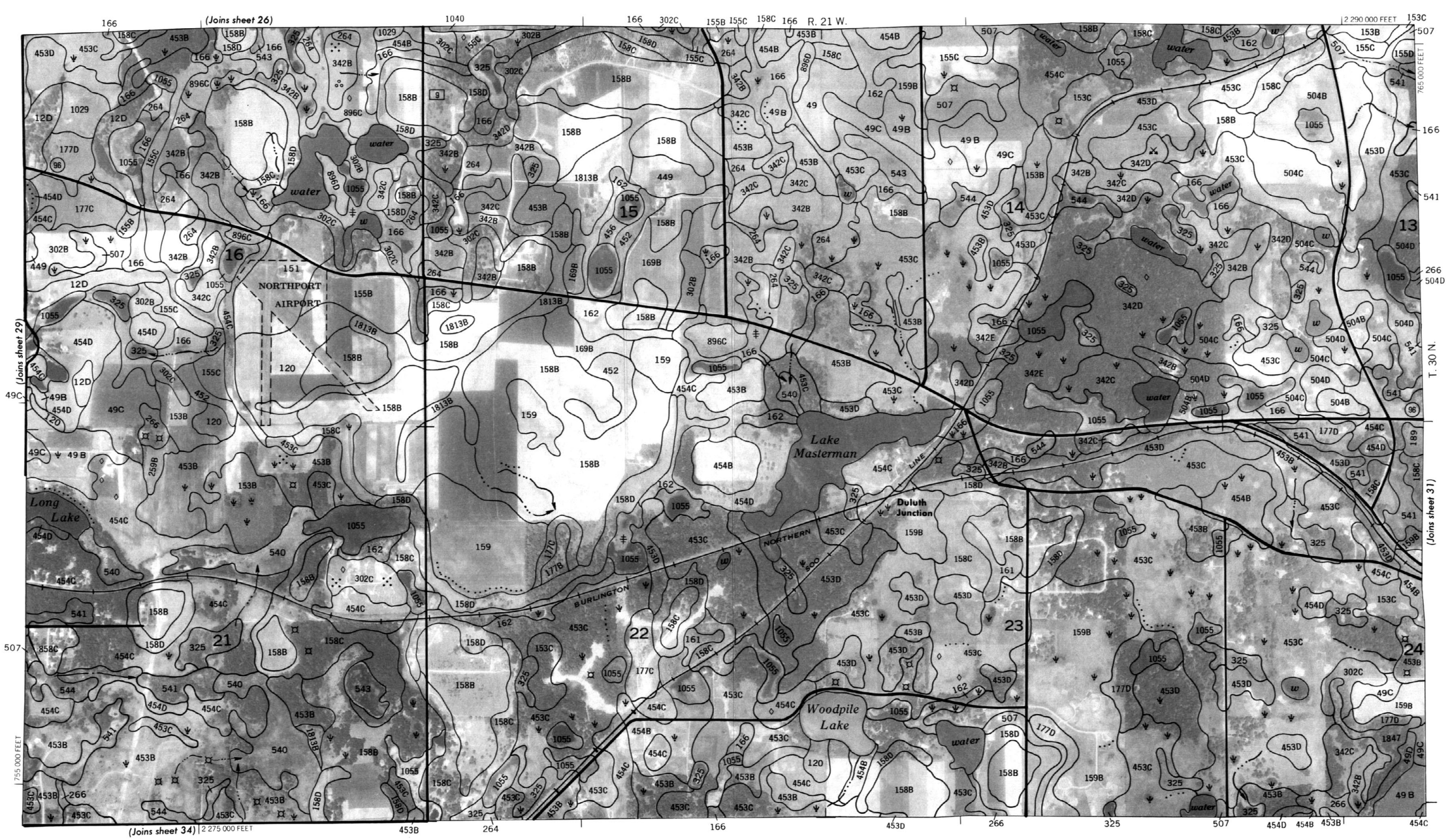
1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

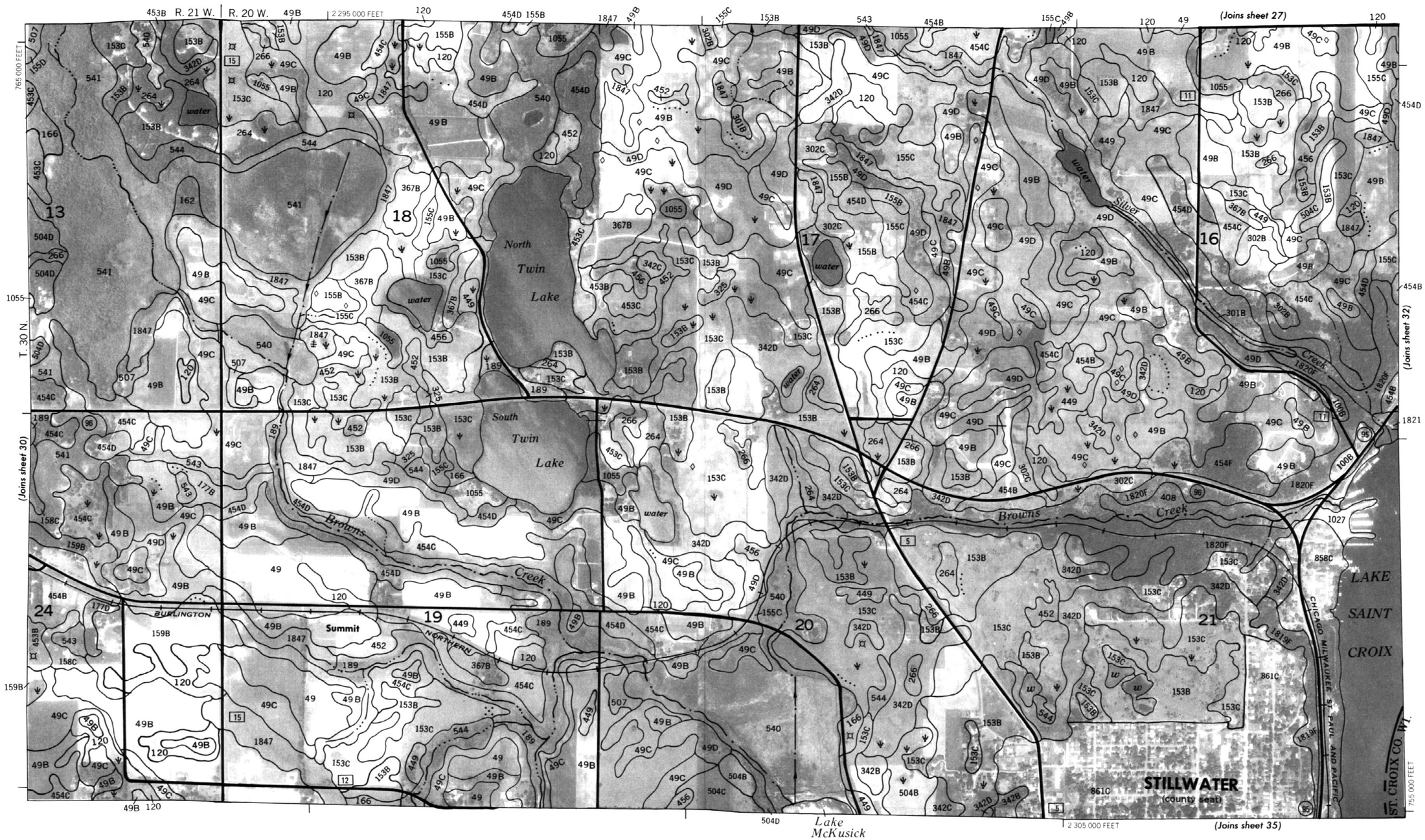
0 1 000 2 000 3 000 4 000 5 000



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 30

WASHINGTON COUNTY, MINNESOTA NO. 31
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



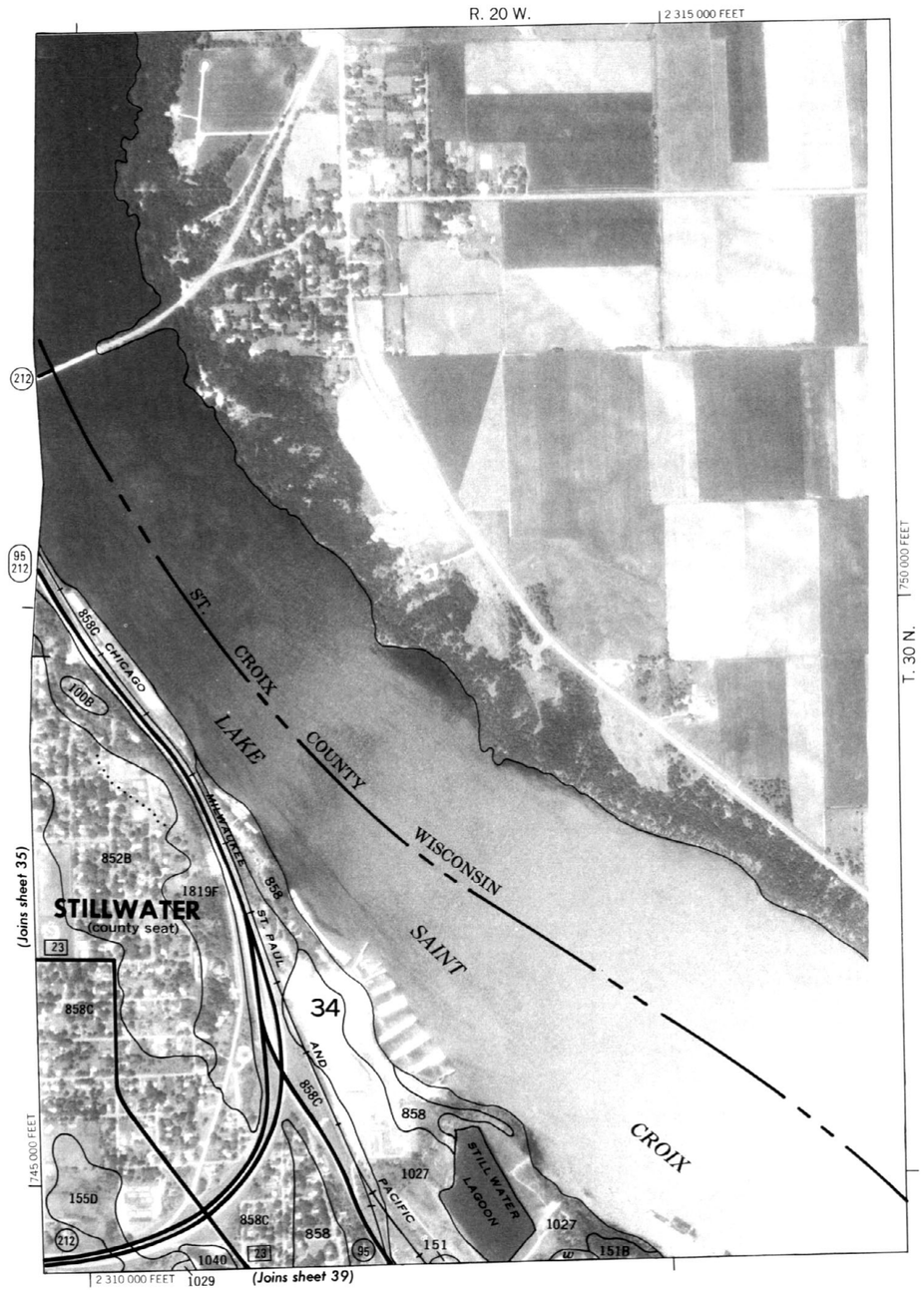
32

N

1 Mile 5 000 Feet

Scale 1:15 840

1 5 000 0 0 ¾ 4 000 ½ 3 000 ¼ 2 000 0 1 000

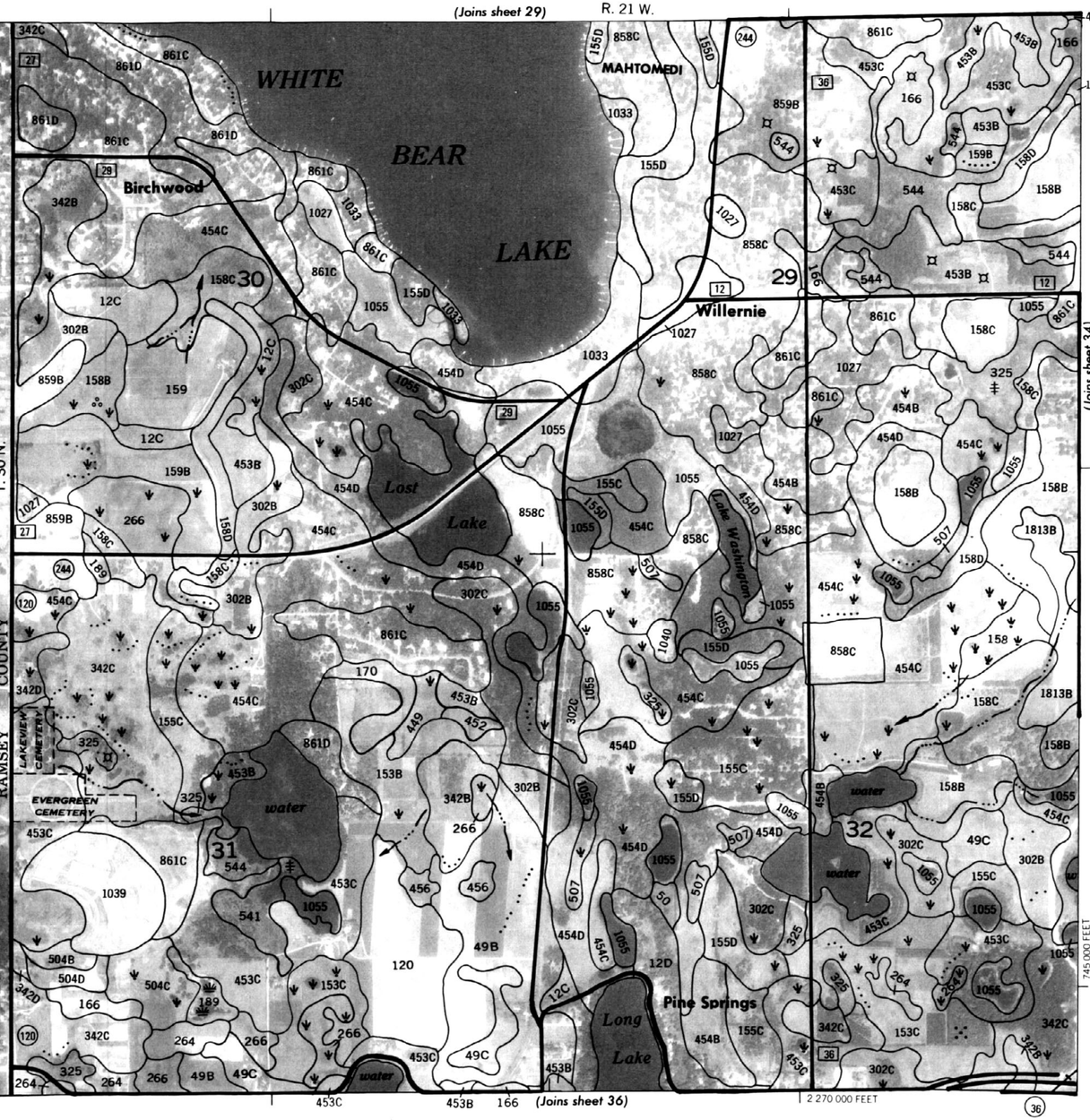


This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 32

WASHINGTON COUNTY, MINNESOTA NO. 33

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



33

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

34

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

(Joins sheet 30)

R. 21 W.

(Joins sheet 33)

(Joins sheet 35)

(Joins sheet 37)

2 290 000 FEET

2 275 000 FEET

745 000 FEET

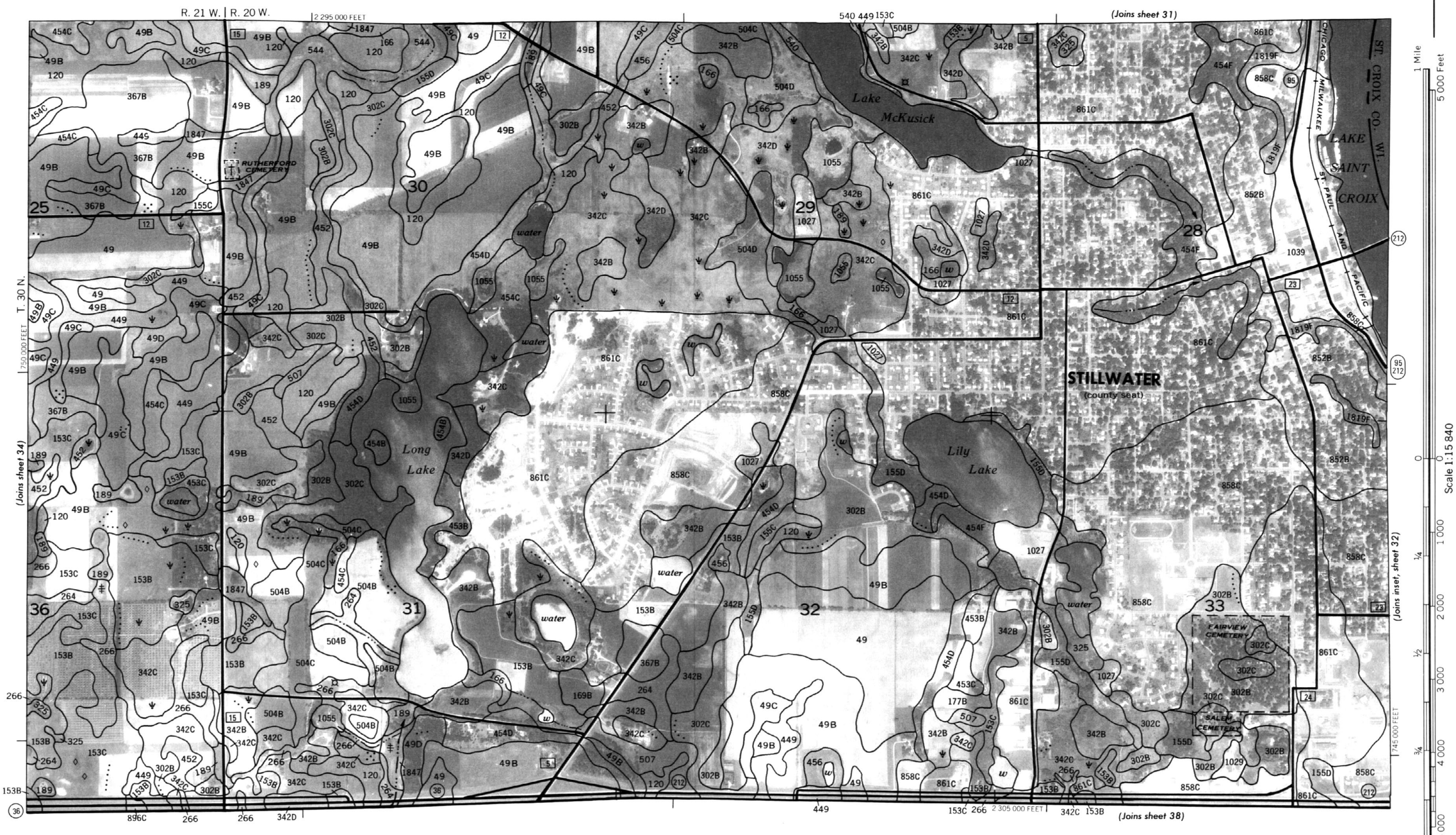
750 000 FEET

Sunnybrook Lake

T. 30 N.

WASHINGTON COUNTY, MINNESOTA NO. 34

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



35

N

1 Mile

5 000 Feet

Scale 1:15 840

36

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

2 255 000 FEET

735 000 FEET

RAMSEY COUNTY

453C (Joins sheet 33)

R. 21 W.

2 270 000 FEET

740 000 FEET

T. 29 N.

OAKDALE

Silver Lake

Long Lake

Mud Lake

Lake DeMontreville

Lake Olson

water

6

5

7

8

(Joins sheet 40)

(Joins sheet 37)

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 36

WASHINGTON COUNTY, MINNESOTA NO. 37

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

37

N

R. 21 W.

T. 29 N.

2 275 000 FEET

740 000 FEET

2 290 000 FEET

735 000 FEET

(Joins sheet 34)

(Joins sheet 36)

(Joins sheet 38)

(Joins sheet 41)

Lake DeMontreville

Lake Olson

Lake Jane

Clear Lake

water

1 Mile

5 000 Feet

Scale 1:15 840

1 000 2 000 3 000 4 000 5 000

38

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0 ¼ 1 000 ½ 2 000 ¾ 4 000 1 5 000

(Joins sheet 35) R. 21 W. R. 20 W.

2 305 000 FEET

740 000 FEET

735 000 FEET

2 295 000 FEET

(Joins sheet 37)

(Joins sheet 42)

(Joins sheet 39)

T. 29 N.

Oak Park Heights

Cloverdale Lake

McDonald Lake

Siegel

CHRIST CEMETERY

CHICAGO NORTHWESTERN LAND

1 2 3 4 5 6 7 8 9 10 11 12

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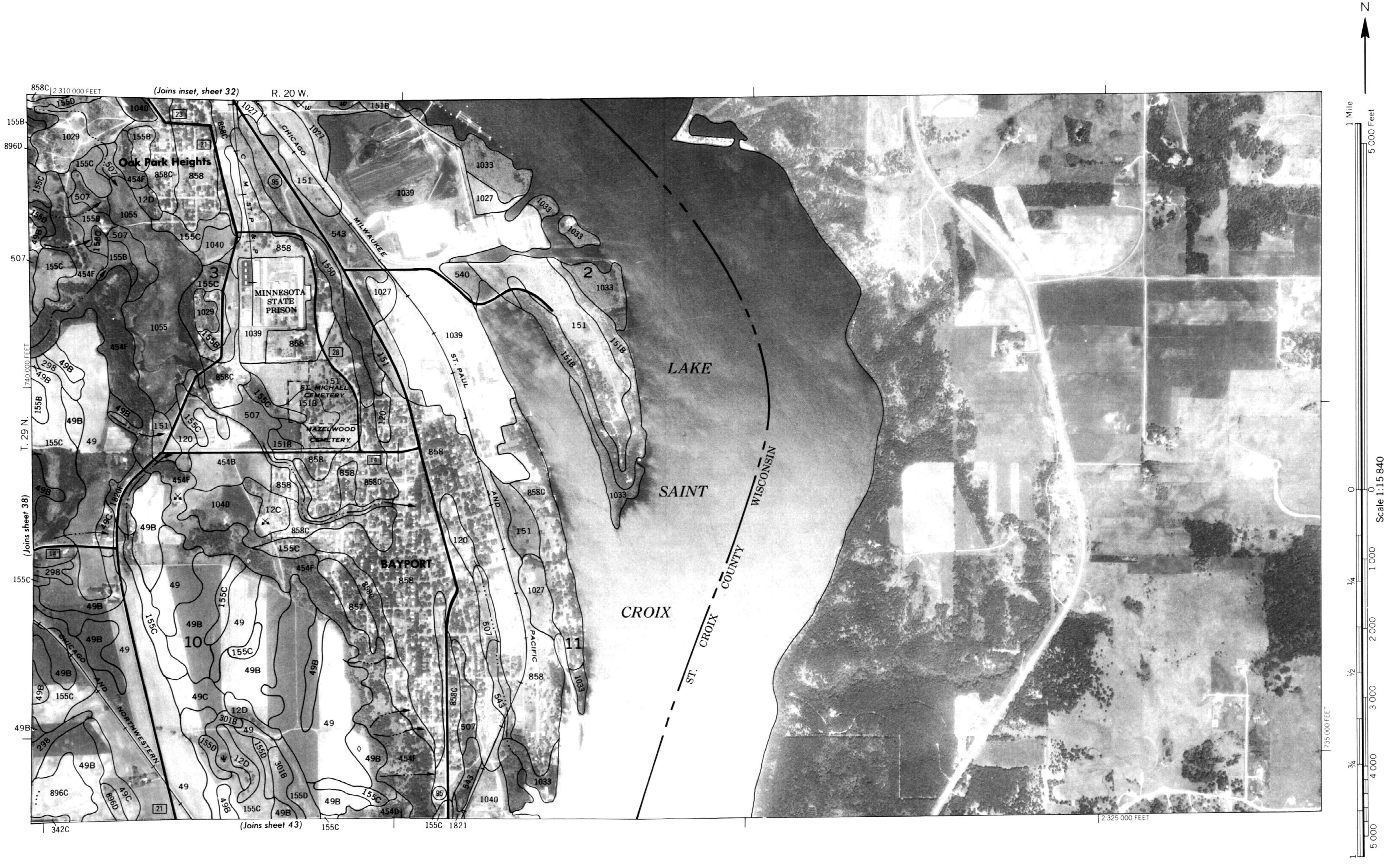
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 38



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

40

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

(Joins sheet 36)

R. 21 W.

2 270 000 FEET

730 000 FEET

725 000 FEET

2 255 000 FEET

T. 29 N.

COUNTY

RAMSEY

OAKDALE

NORTHWESTERN

CHICAGO

ANR

water

(Joins sheet 41)

(Joins sheet 44)

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 40

WASHINGTON COUNTY, MINNESOTA NO. 41

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

41

N

1 Mile
5 000 Feet

Scale 1:15 840

R. 21 W.

T. 29 N.

2 275 000 FEET

730 000 FEET

2 290 000 FEET

725 000 FEET

(Joins sheet 37)

(Joins sheet 40)

(Joins sheet 42)

(Joins sheet 45)

Sunfish Lake

Lake Elmo

LAKE ELMO

Eagle Point Lake

CHICAGO AND NORTHWESTERN

15

16

14

13

22

23

21

24

(42)

N

R. 21 W. | R. 20 W.

(Joins sheet 38)

(Joins sheet 41)

(Joins sheet 43)

(Joins sheet 46)

2 305 000 FEET

2 295 000 FEET

730 000 FEET

725 000 FEET

T. 29 N.

13 18 17 16 24 19 20 21

LAKE ELMO AIRPORT

Downs Lake

water

NORTHWESTERN AND CHICAGO

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 42

WASHINGTON COUNTY, MINNESOTA NO. 43

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating ... Mes.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

43

N

1 Mile

5 000 Feet

Scale 1:15 840

2 310 000 FEET

730 000 FEET

725 000 FEET

2 325 000 FEET

R. 20 W.

T. 29 N.

15

22

21

(Joins sheet 39)

(Joins sheet 42)

(Joins sheet 47)

LAKE

SAINT CROIX COUNTY

WISCONSIN

CROIX

CHICAGO AND NORTHWESTERN

PACIFIC AND CHICAGO MILWAUKEE ST. PAUL

44

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

715 000 FEET

2 255 000 FEET

2 270 000 FEET

720 000 FEET

R. 21 W.

T. 29 N.

RAMSEY COUNTY

OAKDALE

Tanners Lake

Landfall

water

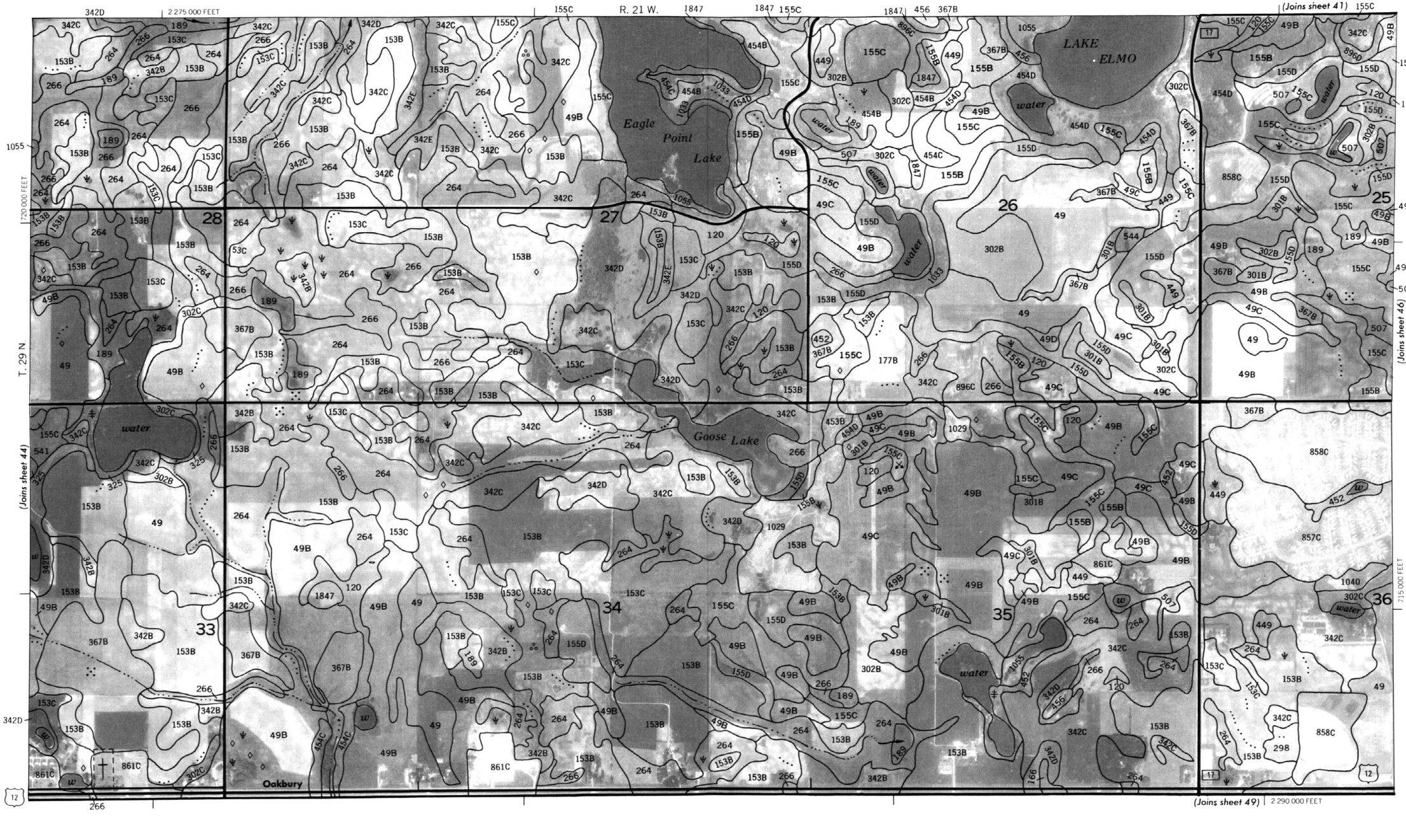
(Joins sheet 40)

(Joins sheet 45)

(Joins sheet 48)

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 44


45
N
R. 21 W.
T. 29 N
2 275 000 FEET
720 000 FEET
715 000 FEET
2 290 000 FEET
(Joins sheet 41)
(Joins sheet 46)
(Joins sheet 44)
(Joins sheet 49)
Eagle Point Lake
Goose Lake
LAKE ELMO
Oakbury
28
27
26
25
34
35
36
33
1 Mile
5 000 Feet
Scale 1:15 840

(46)

N

R. 21 W. | R. 20 W.

(Joins sheet 42)

(Joins sheet 45)

(Joins sheet 47)

(Joins sheet 50)

T. 29 N.

25 30 29 28 36 31 32 33

Horseshoe Lake

Sunfish Lake

water

RENTZ CEMETERY

2 310 000 FEET

2 295 000 FEET

720 000 FEET

715 000 FEET

1 Mile 5 000 Feet

Scale 1:15 840

1 0 0 1/4 1 000 1/2 2 000 3/4 3 000 1 4 000 5 000

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 46

WASHINGTON COUNTY, MINNESOTA NO. 47

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

47

N

1 Mile

5 000 Feet

Scale 1:15 840

2 310 000 FEET

720 000 FEET

715 000 FEET

2 325 000 FEET

R. 20 W.

T. 29 N.

(Joins sheet 43)

(Joins sheet 46)

(Joins sheet 51)

LAKE SAINT CROIX

ST. CROIX COUNTY WISCONSIN

CHICAGO MILWAUKEE ST. PAUL PACIFIC AND

Lakeland

Lakeland Shores

155B 155C 155D 454C 454D 411B 411 49 49B 49C 49D 1040 298 1821 301B 327 454F 151B 944 342B 607 1847 896D 896C 12C 12D 411C 1029 298B 327B 7B 7C 8C 858 858C 151 329 12 21 26 27 34 35 95 94 30

48

N

1 Mile 5 000 Feet

0 0

Scale 1:15 840

¼ 1 000

½ 2 000

¾ 4 000

1 5 000

205 000 FEET

2 260 000 FEET

2 270 000 FEET

710 000 FEET

T. 28 N.

R. 21 W.

(Joins sheet 44)

(Joins sheet 49)

(Joins sheet 52)

RAMSEY COUNTY

WASHINGTON COUNTY

Battle Creek Lake

Woodbury

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 48

R. 21 W.
T. 28 N.
Oakbury
Markgrafs Lake
Wilmes Lake
Powers Lake
water
ST. JOHNS CEMETERY
Oakbury
(Joins sheet 45)
(Joins sheet 48)
(Joins sheet 50)
(Joins sheet 53)
861C
454C
342B
342C
342D
504B
504C
504D
49B
49C
49D
153B
153C
302B
302C
454B
454C
454D
12D
120
452
544
264
266
1 Mile
5 000 Feet
Scale 1:15 840

50

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0 ¼ 1 000 ½ 2 000 ¾ 4 000 1 5 000

(Joins sheet 46) R. 21 W. | R. 20 W.

(Joins sheet 49)

(Joins sheet 54)

(Joins sheet 51)

2 310 000 FEET

2 295 000 FEET

705 000 FEET

710 000 FEET

T. 28 N.

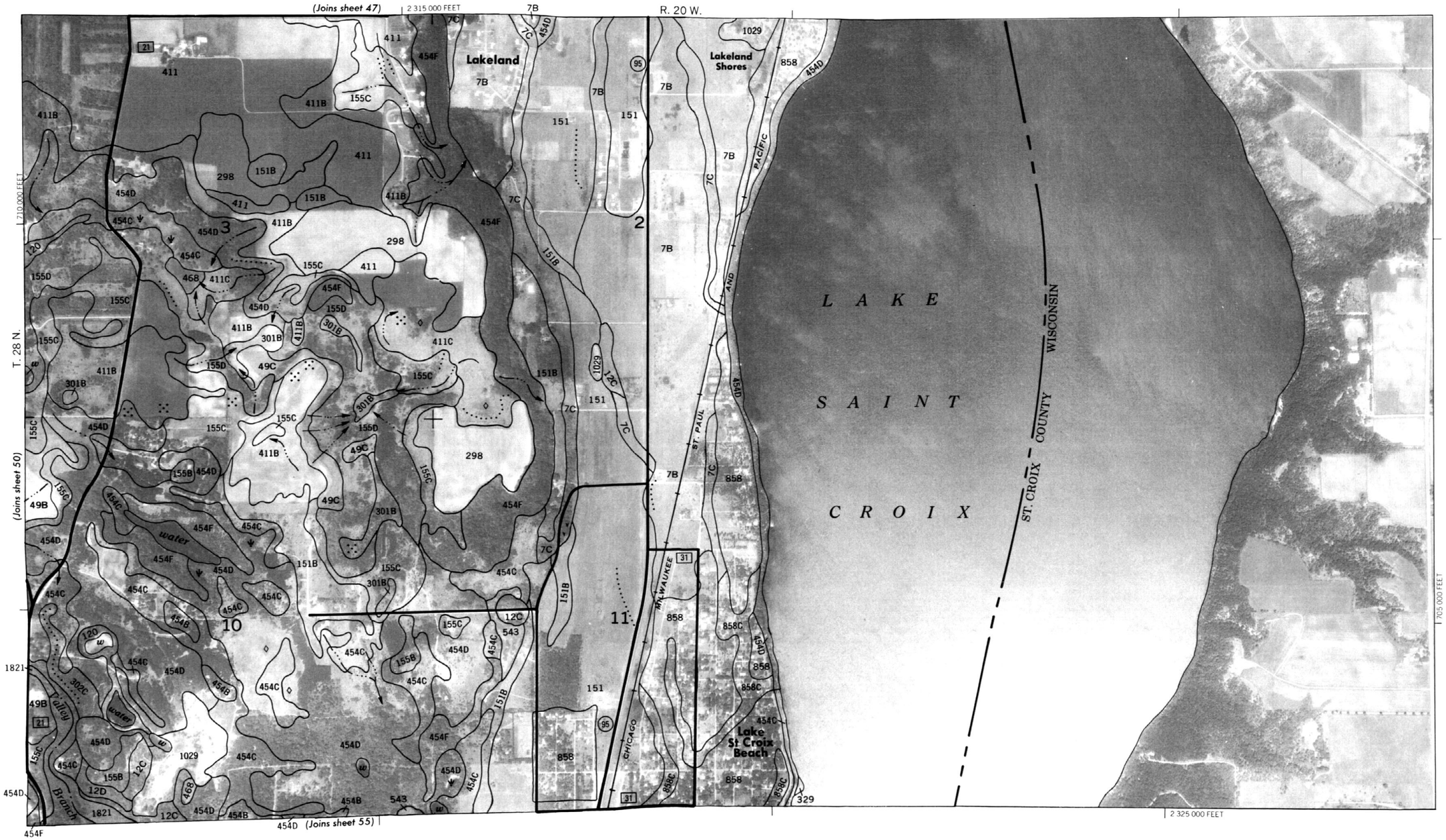
Lake Edith

Valley Branch

Bissels Mounds

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 50


(Joins sheet 47)
2 315 000 FEET
R. 20 W.
T. 28 N.
210 000 FEET
1821
454D
454F
(Joins sheet 50)
(Joins sheet 55)
Lakeland
Lakeland Shores
Lake St Croix Beach
L A K E
S A I N T
C R O I X
WISCONSIN
ST. CROIX COUNTY
PACIFIC
ST. PAUL
MILWAUKEE
CHICAGO
AND
Valley Branch
water
2 325 000 FEET
705 000 FEET
10
11
2
3
329
1 Mile
5 000 Feet
Scale 1:15 840

52

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0 1 000 2 000 3 000 4 000 5 000

¼ ½ ¾ 1

RAMSEY COUNTY

2 255 000 FEET

690 000 FEET

695 000 FEET

685 000 FEET

2,254,000 FEET

1000 AND 5000-FOOT GRID TICKS

2 260 000 FEET

2 270 000 FEET

700 000 FEET

(Joins sheet 48)

(Joins sheet 56)

(Joins sheet 53)

(Joins sheet 56)

MISSISSIPPI

DAKOTA

COUNTY

RIVER

RAMSEY COUNTY

Carver Lake

Woodbury

water

494

25

18

19

20

17

T. 28 N.

R. 21 W.

264

507

266

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 52

WASHINGTON COUNTY, MINNESOTA NO. 53

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

53

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 21 W.

T. 28 N.

2 275 000 FEET

700 000 FEET

695 000 FEET

2 290 000 FEET

(Joins sheet 49)

(Joins sheet 52)

(Joins sheet 54)

(Joins sheet 57)

Colby Lake

water

16 15 14 13

21 22 23 24

54

N

R. 21 W. | R. 20 W.

T. 28 N.

(Joins sheet 50)

(Joins sheet 53)

(Joins sheet 55)

(Joins sheet 58)

MOUND PRAIRIE CEMETERY

2 310 000 FEET

2 295 000 FEET

700 000 FEET

695 000 FEET

1821

449

13 18 17 16 24 19 20 21

1 Mile 5 000 Feet

Scale 1:15 840

0 0 1/4 1 000 1/2 2 000 3/4 4 000 1 5 000

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 54

N

WASHINGTON COUNTY, MINNESOTA NO. 55

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(Joins sheet 51)

2 315 000 FEET

R. 20 W.

700 000 FEET

T. 28 N.

(Joins sheet 54)

(Joins sheet 59)

2 325 000 FEET

695 000 FEET

LAKE SAINT CROIX

ST. CROIX COUNTY WISCONSIN

SAINT CROIX RIVER

St Marys Point

Afton

Valley Branch

ST. PAUL AND PACIFIC

CHICAGO MILWAUKEE

15 14 22 23

1 Mile

5 000 Feet

Scale 1:15 840

56

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

RAMSEY COUNTY

R. 22 W. | R. 21 W.

(Joins sheet 52)

(Joins inset, sheet 52)

2 270 000 FEET

690 000 FEET

685 000 FEET

T. 28 N.

(Joins sheet 57)

(Joins sheet 60)

2 260 000 FEET

Ria Lake

La Lake

NEWPORT

CHICAGO MILWAUKEE ST. PAUL AND PACIFIC NORTHERN

MISSISSIPPI RIVER

DAKOTA COUNTY

26 25 30 29 35 36 31 32

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 56

2 275 000 FEET
R. 21 W.
(Joins sheet 53)
2C
690 000 FEET
T. 28 N.
SALEM CEMETERY
28
27
26
25
33
34
35
36
water
(Joins sheet 56)
(Joins sheet 58)
(Joins sheet 61)
2 290 000 FEET
685 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840

58

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

685 000 FEET

2 295 000 FEET

2 310 000 FEET

690 000 FEET

(Joins sheet 54)

(Joins sheet 57)

(Joins sheet 62)

(Joins sheet 59)

R. 21 W. | R. 20 W.

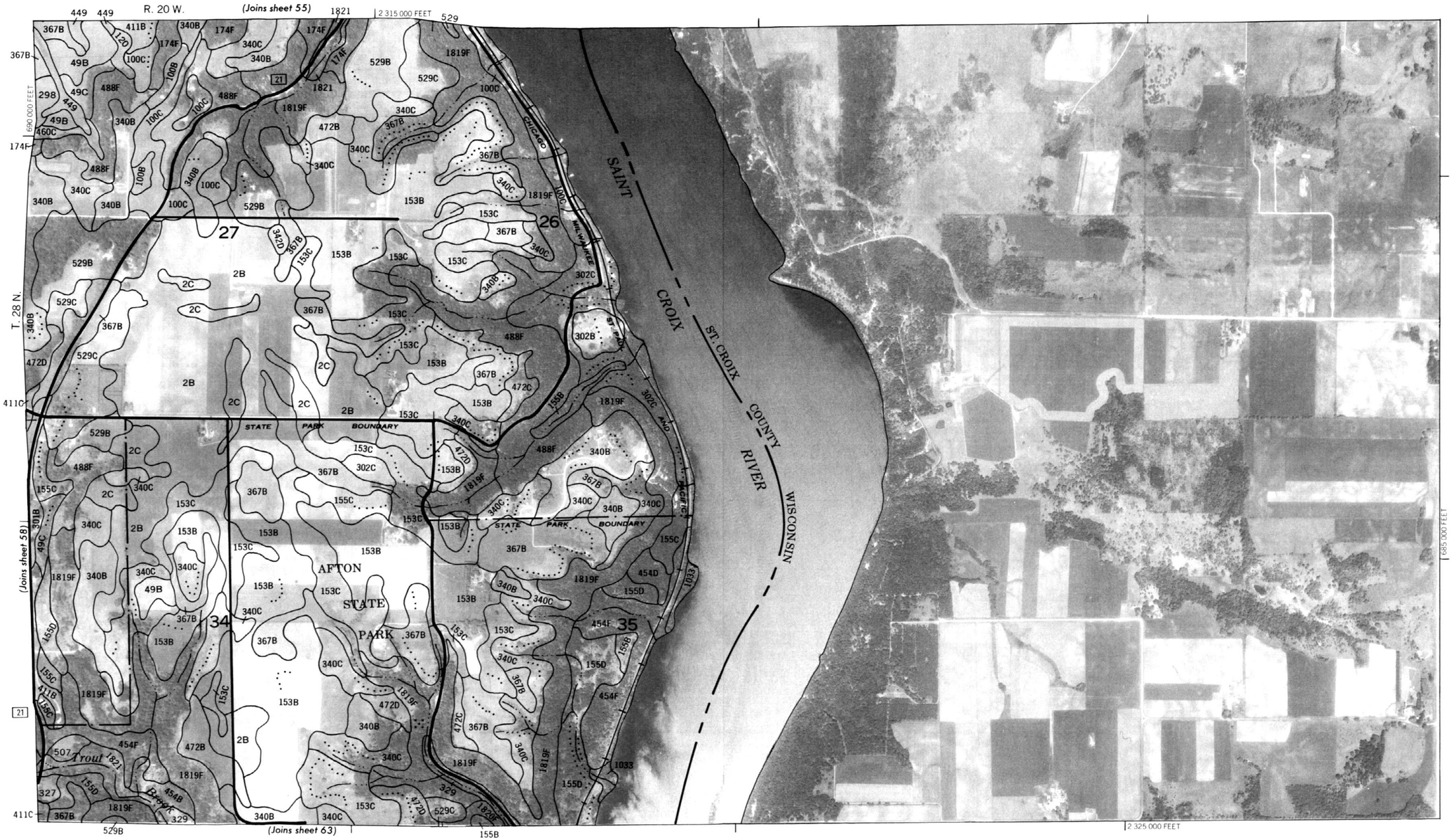
T. 28 N.

25 30 29 28 36 31 32 33

Brook Trout

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 58


R. 20 W.
(Joins sheet 55)
2 315 000 FEET
2 325 000 FEET
690 000 FEET
685 000 FEET
T. 28 N.
(Joins sheet 58)
(Joins sheet 63)
SAINT CROIX
ST. CROIX COUNTY
WISCONSIN
RIVER
STATE PARK BOUNDARY
AFTON STATE PARK
Trout Brook
CHICAGO MILWAUKEE ST. PAUL AND PACIFIC
27
26
34
35
21
N
1 Mile
5 000 Feet
Scale 1:15 840
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000

60

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 56)

R. 22 W. | R. 21 W.

2 270 000 FEET

680 000 FEET

T. 27 N.

(Joins sheet 61)

670 000 FEET

2 260 000 FEET

(Joins sheet 64)

MISSISSIPPI RIVER

DAKOTA COUNTY

CHICAGO ROCK ISLAND AND PACIFIC

BURLINGTON NORTHERN

MILWAUKEE

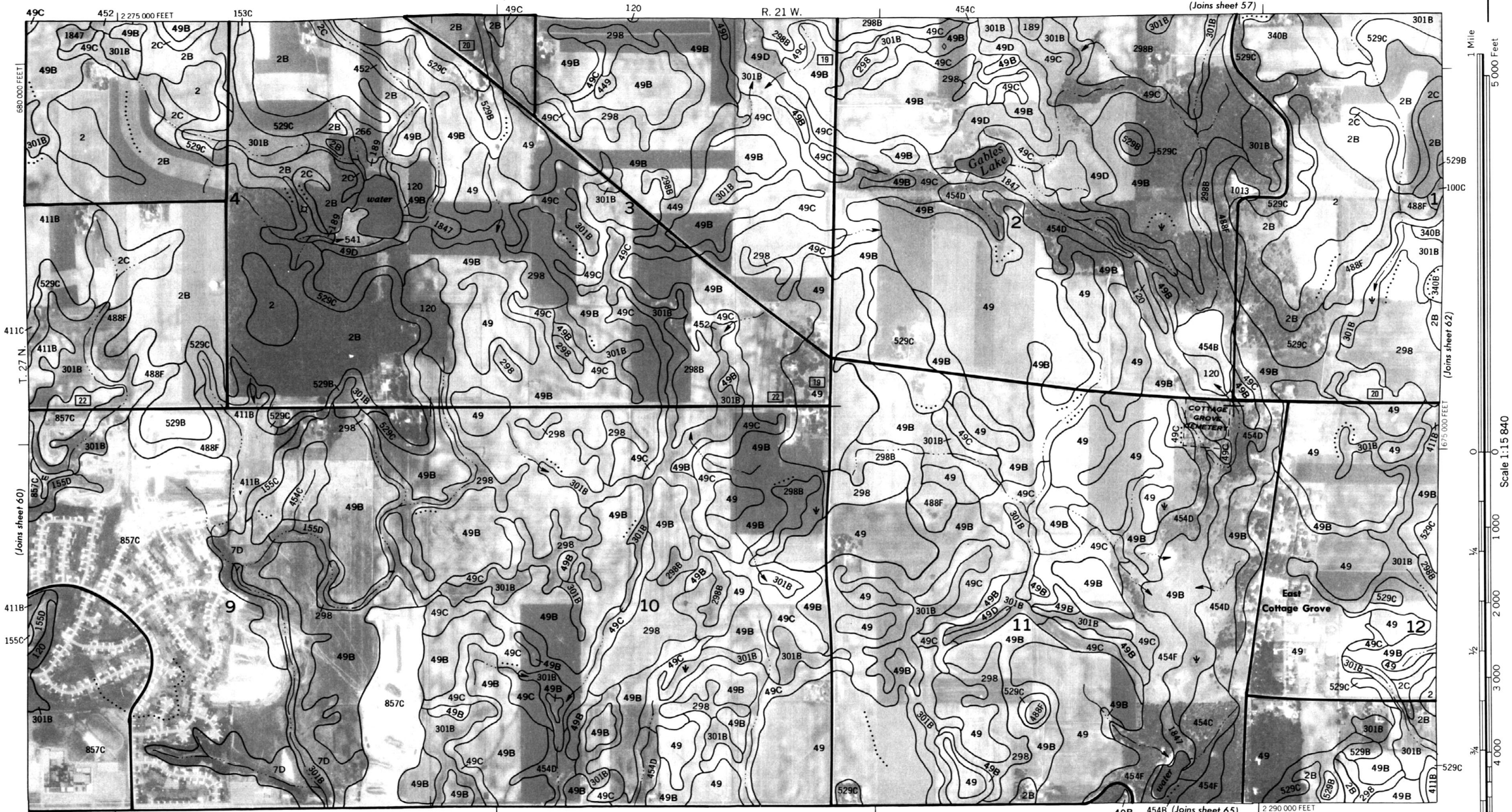
ST PAUL AND PACIFIC

NEWPORT CEMETERY

ST PAUL PARK

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 60


61
N
R. 21 W.
T. 27 N.
2 275 000 FEET
2 290 000 FEET
680 000 FEET
675 000 FEET
(Joins sheet 57)
(Joins sheet 60)
(Joins sheet 62)
(Joins sheet 65)
Gables Lake
COTTAGE GROVE CEMETERY
East Cottage Grove
water
1 Mile
5 000 Feet
Scale 1:15 840

62

N

R. 21 W. | R. 20 W.

(Joins sheet 58)

(Joins sheet 61)

(Joins sheet 63)

(Joins sheet 66)

T. 27 N.

2 310 000 FEET

680 000 FEET

675 000 FEET

2 295 000 FEET

Brook

Trout

water

1 Mile 5 000 Feet

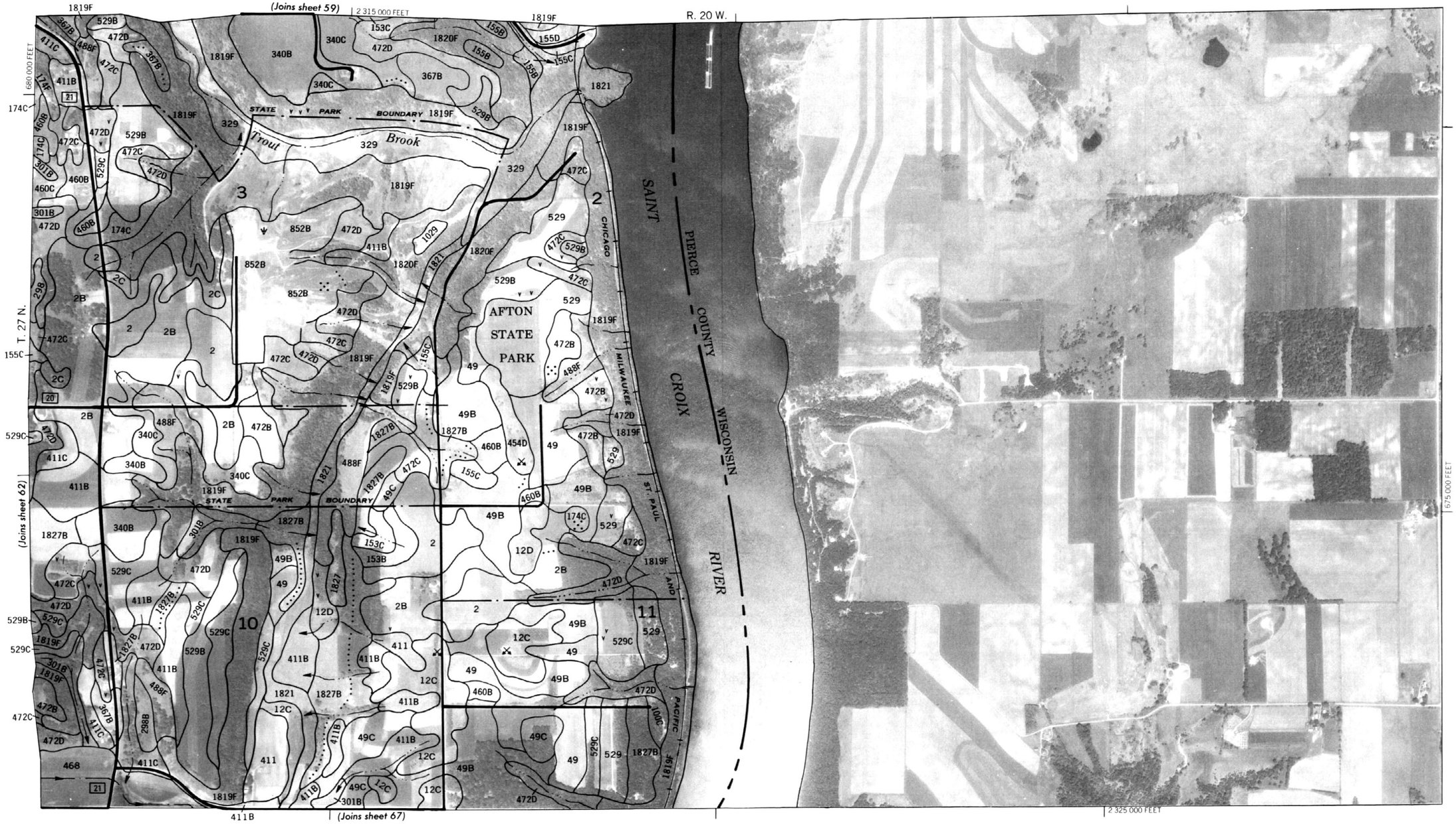
Scale 1:15 840

1/4 0 1/4 1/2 3/4 1

1 000 0 1 000 2 000 3 000 4 000 5 000

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 62


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 59)
2 315 000 FEET
R. 20 W.
680 000 FEET
675 000 FEET
2 325 000 FEET
T. 27 N.
STATE PARK BOUNDARY
Trout Brook
AFTON STATE PARK
SAINT CROIX RIVER
PIERCE COUNTY, WISCONSIN
CHICAGO
MILWAUKEE
ST. PAUL AND PACIFIC
(Joins sheet 62)
(Joins sheet 67)

64

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 60)

R. 22 W. | R. 21 W.

2 270 000 FEET

670 000 FEET

T. 27 N.

(Joins sheet 65)

ST PAUL PARK

COTTAGE GROVE

ATKINSON CEMETERY

MISSISSIPPI RIVER

DAKOTA COUNTY

Upper Grey Cloud Island

Grey Cloud Channel

CHICAGO MILWAUKEE ST. PAUL AND PACIFIC

BURLINGTON NORTHERN

water

13 14 17 18 19 20 23 24

(Joins sheet 68)

2 260 000 FEET

650 000 FEET

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 64

WASHINGTON COUNTY, MINNESOTA NO. 65

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

65

N

2 275 000 FEET

670 000 FEET

R. 21 W.

(Joins sheet 61)

(Joins sheet 64)

(Joins sheet 66)

(Joins sheet 69)

2 290 000 FEET

660 000 FEET

T. 27 N.

COTTAGE GROVE

Langdon

CHICAGO MILWAUKEE ST. PAUL AND PACIFIC

water

16 15 14 13 21 22 23 24

1 Mile

5 000 Feet

Scale 1:15 840

66

N

R. 21 W. | R. 20 W.

T. 27 N.

(Joins sheet 62)

(Joins sheet 65)

(Joins sheet 67)

(Joins sheet 70)

2 310 000 FEET

2 295 000 FEET

670 000 FEET

660 000 FEET

13 18 17 16

24 19 20 21

EVERGREEN CEMETERY

1 Mile

5 000 Feet

Scale 1:15 840

1 0 1 000 2 000 3 000 4 000 5 000

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 66

WASHINGTON COUNTY, MINNESOTA NO. 67
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(Joins sheet 63)
(Joins sheet 66)
(Joins sheet 71)
(Joins sheet 68)

R. 20 W. | 2 315 000 FEET
R. 22 W. | 2,254,000 FEET
T. 27 N. | 670 000 FEET
T. 27 N. | 655 000 FEET
665 000 FEET
650 000 FEET
2 255 000 FEET
2 325 000 FEET

Basswood Grove
Elevator Bay
SAINT CROIX RIVER
PIERCE COUNTY WISCONSIN
MISSISSIPPI RIVER
DAKOTA COUNTY
Upper Grey Cloud Island
MILWAUKEE
CHICAGO
PACIFIC
AND
ST. PAUL

15 14 22 26 35

1000 AND 5000-FOOT GRID TICKS

67

N

1 Mile
5 000 Feet

Scale 1:15 840

68

N

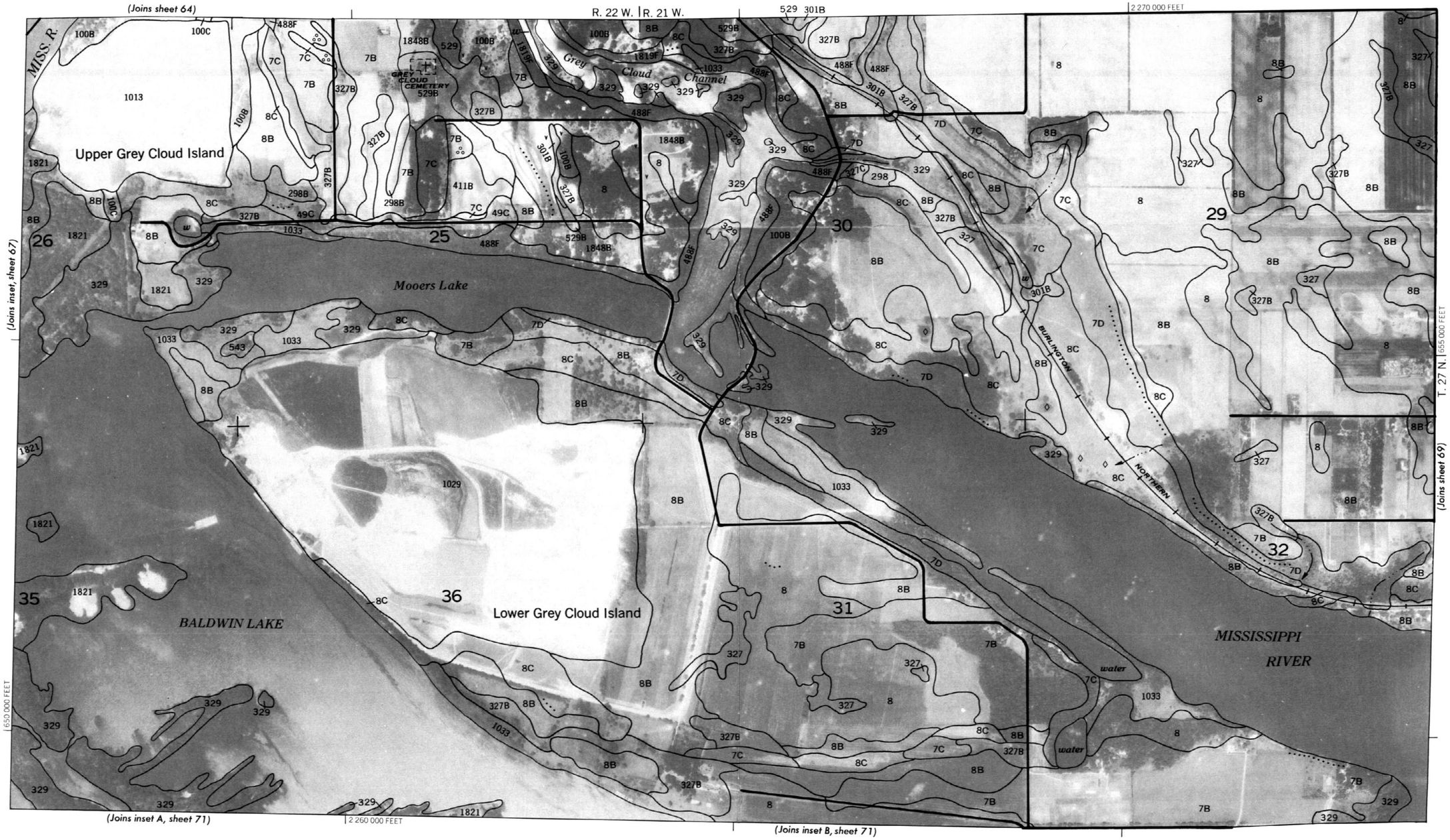
1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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WASHINGTON COUNTY, MINNESOTA NO. 68

WASHINGTON COUNTY, MINNESOTA NO. 69

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2 275 000 FEET

R. 21 W.

(Joins sheet 65)

(Joins sheet 68)

T. 27 N.

655 000 FEET

650 000 FEET

2 290 000 FEET

(Joins inset B, sheet 71)

(Joins sheet 72)

(Joins sheet 70)

CHICAGO MILWAUKEE ST. PAUL & PACIFIC

BURLINGTON NORTHERN

MISSISSIPPI RIVER

DAKOTA COUNTY

Chemolite

water

N

1 Mile

5 000 Feet

Scale 1:15 840

70

N

R. 21 W. | R. 20 W.

(Joins sheet 66)

(Joins sheet 69)

(Joins sheet 71)

(Joins sheet 72)

2 310 000 FEET

660 000 FEET

650 000 FEET

2 295 000 FEET

T. 27 N.

Scale 1:15 840

1 Mile 5 000 Feet

0 1 000 2 000 3 000 4 000 5 000

¼ ½ ¾ 1

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WASHINGTON COUNTY, MINNESOTA NO. 70

N

R. 20 W. (Joins sheet 67)

2 315 000 FEET

660 000 FEET

T. 27 N.

(Joins sheet 70)

411B 411B 411B 411 7D 411 411B 411B 411 7D 411B 298 411 411B 298 327B 1827B 411 100C 100B 411B 529B 1821 CHICAGO 1820F MILWAUKEE 1821 529 529B 472C 1819F 472C 155C 1820F 1821 27 1819F PACIFIC 1827B 472B 472B 529 529B 1819F AND ST. PAUL 100C 327B

SAINT CROIX RIVER

PIERCE COUNTY WISCONSIN

INSET A

2,256,000 FEET

R. 22 W. (Joins sheet 68)

648,000 FEET

T. 26 N.

2 329 329 329 1 1821 1821

Baldwin Lake

MISSISSIPPI RIVER

DAKOTA COUNTY

647,000 FEET

2 260 000 FEET

1000 AND 4000-FOOT GRID TICKS

INSET B

2 265 000 FEET

R. 21 W. (Joins sheet 68)

648 000 FEET

T. 26 N.

6 8 1033 Lower Grey Cloud Island 7B 5 329

MISSISSIPPI RIVER

1821 1821 1821 1821

DAKOTA COUNTY

(Joins sheet 69)

646,000 FEET

2 270 000 FEET

2000 AND 5000-FOOT GRID TICKS

2 325 000 FEET

655 000 FEET

1 Mile

5 000 Feet

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

Scale 1:15 840

WASHINGTON COUNTY, MINNESOTA NO. 71

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

R. 21 W. | R. 20 W.

(Joins sheet 70)

(Joins sheet 69)

2 310 000 FEET

T. 26 N. | 645 000 FEET

640 000 FEET

2 295 000 FEET

Scale 1:15 840

1 Mile

5 000 Feet

0 0

¼ 1 000

½ 2 000

¾ 4 000

1 5 000

CHICAGO MILWAUKEE AND ST. PAUL RAILROAD

CHICAGO BURLINGTON AND QUINCY RAILROAD

CHICAGO MILWAUKEE ST. PAUL AND PACIFIC RAILROAD

NORTHERN PACIFIC RAILROAD

U.S. HIGHWAY 61

U.S. HIGHWAY 10

U.S. HIGHWAY 21

LOCK AND DAM NO 2

JOHNSON CEMETERY

LEAVITT CEMETERY

Conley Lake

Point Douglas

MISSISSIPPI RIVER

SAINT CROIX RIVER

WISCONSIN

PIERCE COUNTY

DAKOTA COUNTY

1 2 3 4 5 6 7 8 9 10

298 298B 1820F 411 411B 411C 449 2B 2C 2 1040 7C 7D 1029 1819F 49D 529 529B 529C 1827B 1821 301B 327B 329 472B 472C 472D 488F 340B 340C 460B 460C 100B 100C 1827

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WASHINGTON COUNTY, MINNESOTA NO. 72